POWER

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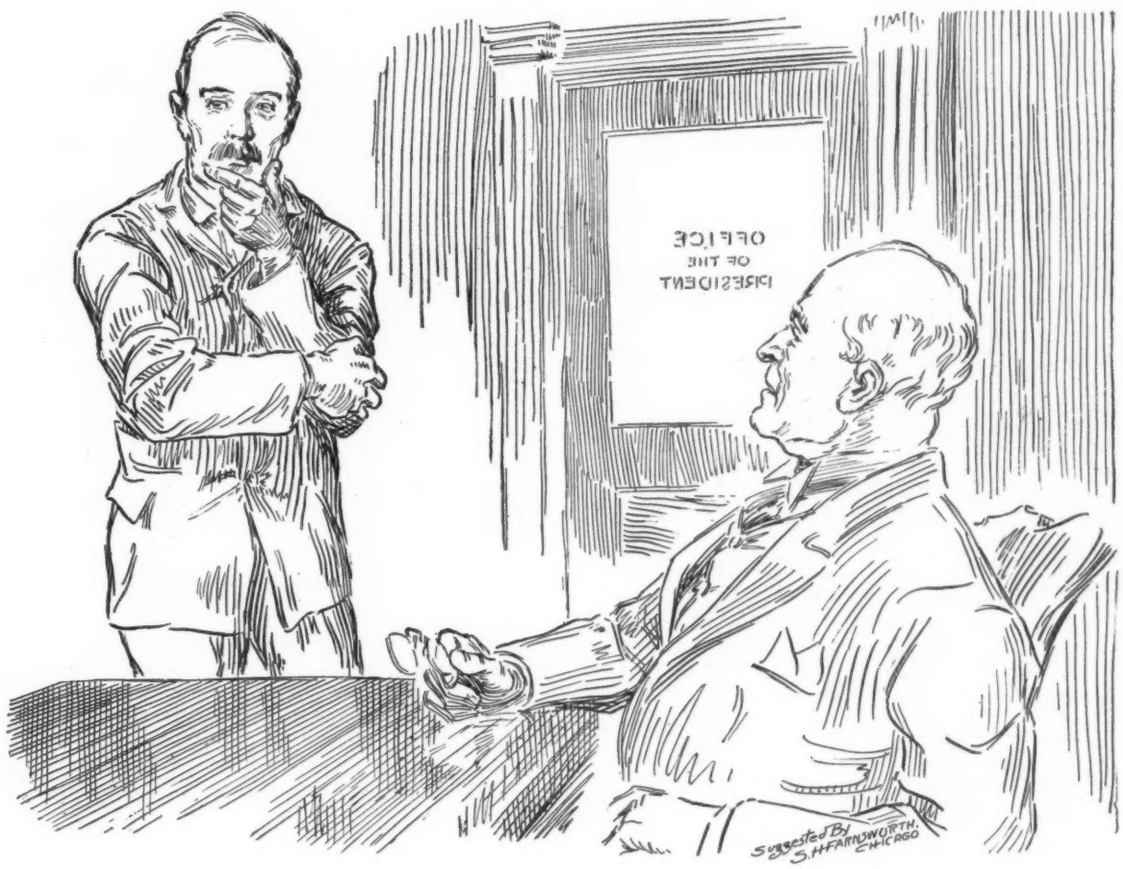
An Anxious Moment



"You have been with us quite a while, George!"

"Nearly fifteen years, sir"—a moment's silence.

"Ahem, we have decided to tear out our present plant, with all its antiquated equipment, which, although all right in its day, has outlived its usefulness. We will install a first-class, uptodate plant, water-tube boilers, mechanical stokers, centrifugal pumps, turbo-generators, and use motors to drive the machines direct.

"Could you handle that type of plant, George?"

What would your answer have to be?

If George has used his spare time for the past 20 years improving his mind and training himself for the change that will come to all of us sooner or later, the anxiety will not last long.

But, if he has just drifted along with the times, taking things as they come, just attending to his duties and allowing his interest in engineering to end with the day's work, he will take second place or join the ever-increasing crowd of ex-engineers.

How Boiler Plate Is Made

By Charles H. Bromley

SYNOPSIS—The reader virtually takes a trip through the mills and sees the manufacturing process from the stock pile to the finished product. The spinning of flanged, bumped boiler heads is described. The imperfections which sometimes exist in the manufacture of the plate and which affect the material for boiler purposes are illustrated and explained.

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The Stock Pile

The manufacture of steel boiler plate really begins at the stock piles, of which there are usually two, one consisting of pig iron and the other of melting scrap.

Fig. 1. Charging Boxes with Scrap on Way to Melting Furnace

Some of the scrap is comparatively free from phosphorous, but the remainder, consisting of steel rails and the usual kinds of scrap purchasable in the market, contains more phosphorus than is permitted in good boiler plate.

The pig iron also usually contains still more phosphorus than the scrap.

This material, however, may be dephosphorized by being melted in a furnace containing a charge of limestone, which when the whole mass is melted absorbs the excess phosphorus.

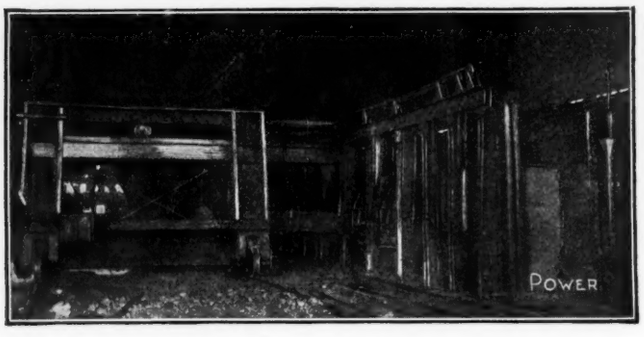


Fig. 2. Crane for Charging Furnace with Scrap

Large gantry cranes carrying magnets load the pig iron and scrap into the charging boxes. Fig. 1 shows a number of these boxes loaded and on their way to the melting furnaces. Holes are drilled in the bottoms of the boxes to prevent an accumulation of water therein which if dumped into the furnace might cause a serious explosion.

Charging the Melting Furnace

When the train load of boxes is left in front of the melting furnaces the horizontal arm of a charging crane slips into a slot in the end of the box and lifts the latter into the furnace. Fig. 2 shows the crane holding the box which is shown at the right.

The melting furnaces, holding 50 tons of metal, are heated with gas furnished by gas producers; the temperature maintained is about 3000 deg. F., at which the steel boils. The gas-flame current playing over the top of the metal is reversible. A "heat" is poured every twelve hours.

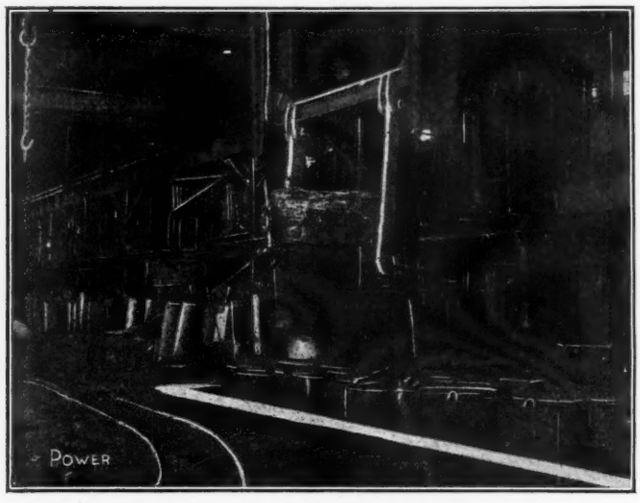


Fig. 3. Pouring Steel into Ingot Molds

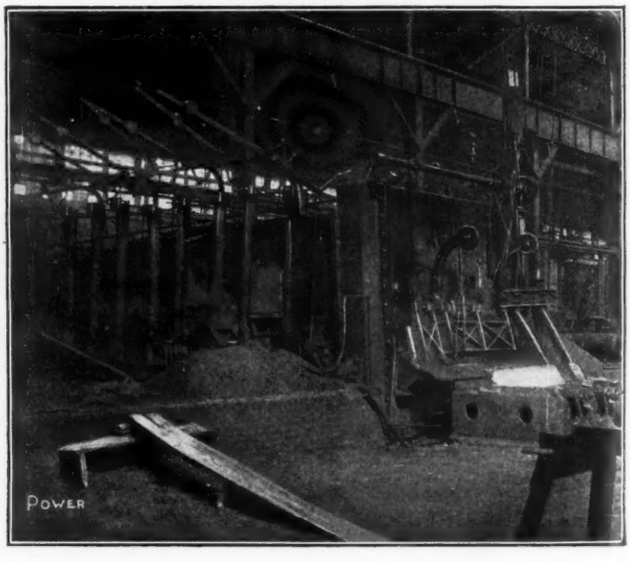


Fig. 4. Bloom after Passing through Continuous Furnace

Pouring the Molten Steel

The pouring side of the melting furnaces is shown in Fig. 3. Here a heat is being poured into the ingot molds from the bottom of a ladle which holds the entire contents of the furnace. This method of pouring is known as "bottom" pouring because the molten steel is poured into a form having passages leading to the bottom of each mold, the metal rising to the top of the molds as the pouring is continued.

Sometimes the steel does not contain the specified amount of carbon and this shortage is not discovered until the metal is being poured into the ladle. To make up this shortage several bags, like flour sacks, are kept full of a high grade of No. 3 buckwheat coal. These bags are thrown into the molten steel as it flows to the ladle. The coal is immediately consumed and some of its carbon content added to the steel.

Heating the Ingots for Rolling

The ingots vary in weight from 500 to 25,000 lb. Marine steel plate being heavy, it is rolled from the larger ingots. After the steel in the molds has solidified and while the ingots are quite hot they are carried by cranes to the continuous furnaces. Here the ingots are put in at one end and carried through to the other, being white hot when they are dropped out at the terminal end, as shown in Fig. 4, which illustrates a heated ingot just dropped from the furnace.

Rolling the Ingots into Plates

In blooming mills the ingots are rolled into blooms and these are cut into billets which are carried by high-speed electric cranes and dropped on the stationary feeder rolls of the plate mill, Fig. 5. The illustration shows a "three-high" mill, so called because it has three reducing rolls. The second set of feeder rolls shown at the end of the stationary feeder rolls may be tipped so as to come in line with the upper or lower reducing rolls.

Fig. 6. Form of a Steel Test-Piece

In a mill so made the hot metal passes through the mill between the middle roll and the upper roll when going one way, and when returning is passed between the lower roll and the middle roll, being made thinner each time it goes through the mill. The work is kept in rapid motion until the plate is reduced to the desired thickness, which is indicated by a gage used by the attendant. The long levers hung by chains from the top of the rolls are used to turn the billet so that it will enter the rolls properly.

Oxidization occurs on the surface of the ingot due to the cooling action, and if the scale were not removed it would be rolled into the metal producing a defective plate. Therefore a steam pipe is provided with nozzles pointing downward to deliver steam jets for blowing the loose scale off the ingot. Sometimes the scale adheres so firmly that the steam jets are not strong enough to remove it. At such times common salt is thrown over the surface of the plate. The salt causes violent explosions as the plate passes through the rolls. The scale is thus loosened and then is blown from the plate by the steam jets.

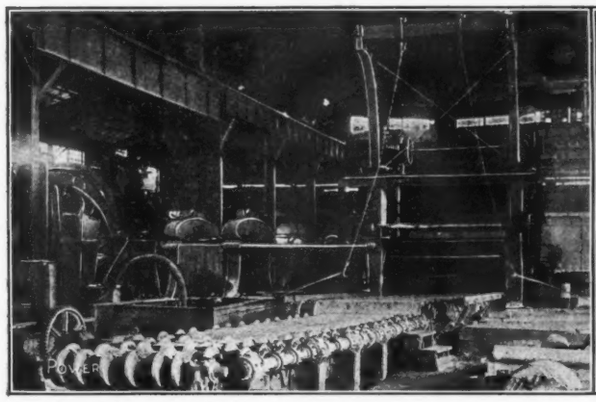


Fig. 5. Rolling Mill

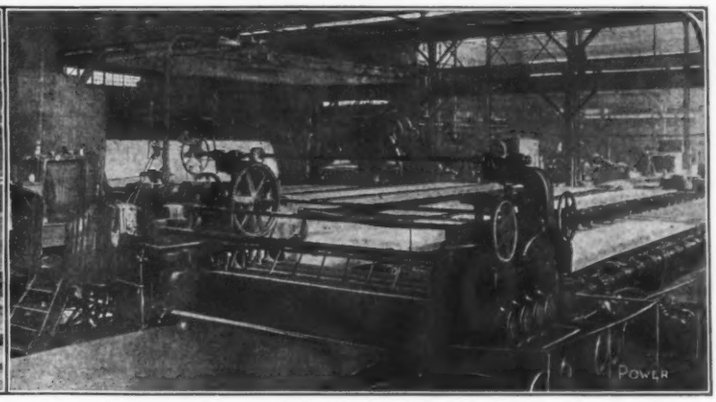


Fig. 7. Straightening Rolls

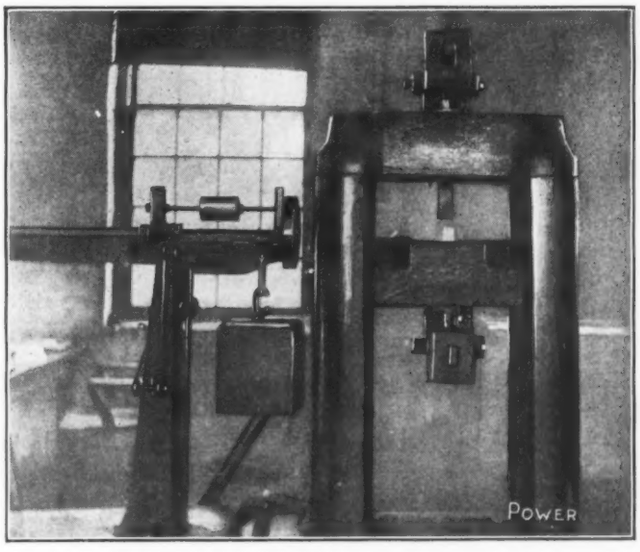


Fig. 8. Machine for Testing Elasticity and Tensile Strength of Plate

It will be understood that the space between the reducing rolls is adjusted each time the hot metal passes through the mill.

From its more frequent use the middle roll wears more rapidly than the upper and lower rolls. This middle roll is taken out and trued up in a large roll lathe, and the top and bottom rolls, which are larger, are trued

up in position by disconnecting the main shaft and substituting motor drive through gears to obtain a slow speed, a tool rest being provided in front of the roll. Each mill is driven by its own engine, which usually is of 3000 or 4000 horsepower.

As the plate is more or less wavy as it comes from the mill, it is continued, while hot, to the straightening

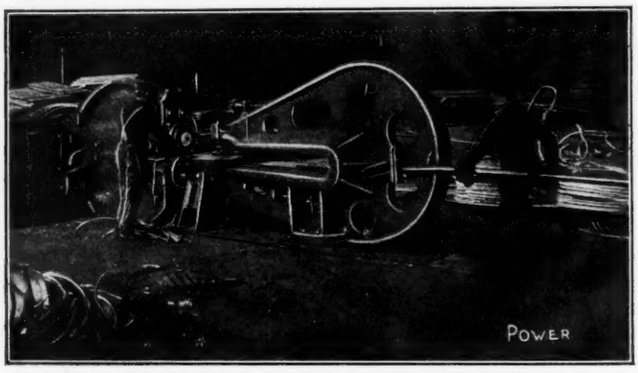


FIG. 9. CUTTING PLATE FOR BOILER HEADS

rolls, Fig. 7. After being straightened the plate is carried at right angles to the rolls and is later tipped up so that both sides may be inspected for defects. The white object in the middle distance, Fig. 7, is a plate, tipped for inspection. The plate is next trimmed and cut into sheets.

TESTING THE PHYSICAL PROPERTIES OF THE PLATE

The finished plate is next given a number and series mark and a "coupon" piece cut from it which is also given the same number and series mark. The "coupons" are of a unit size and milled out to the shape shown in Fig. 6.

To test for elastic limit (permanent stretch) and tensile strength, the machine, Fig. 8, is used. After the ends of the test piece have been gripped in jaws, one stationary and the other movable, the piece is pulled until

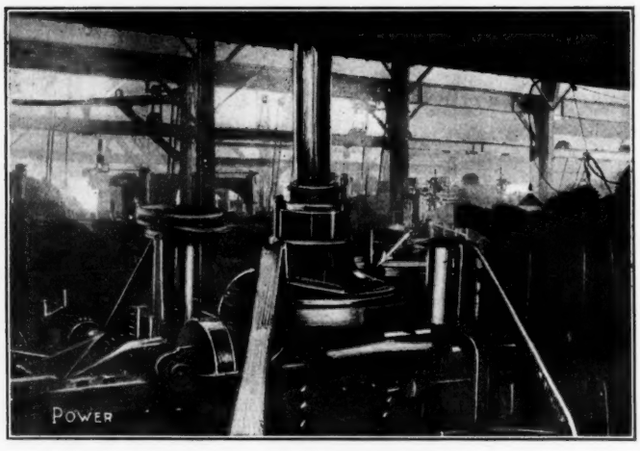


FIG. 10. SPINNING FLANGES ON BOILER-HEAD PLATE

the elastic limit is reached. The number of pounds pull necessary to reach this limit is recorded. Next comes the tensile-strength test. The pull is continued, stretching the piece until it finally breaks, and the pull necessary to produce the break is also recorded. The ductility is determined by the amount of stretch or elongation between two points marked 8 in. apart before pulling. As an additional test for ductility, a piece is subjected to a bending stress by being placed vertically in a hydraulic press and bent double. If the piece breaks or fractures it has not withstood the test.

SPINNING FLANGES ON PLATES FOR BOILER HEAD

The plate is cut into circular pieces of the required diameter by rotary shears shown in Fig. 9. The pieces are then placed in a furnace which heats the entire plate, after which the plate is placed in the spinning machine, Fig. 10, and the flanges turned down. In the illustration the plate is shown in the machine after the flange has been spun.

To put in a plate the top die is raised, and lowered again after the plate is centered, the vertical rollers moving in toward the plate pushing it central on the dies. The machine is then started and as the plate revolves, the wheel, indicated by the arrow, is moved toward the center of the plate and at the same time is moved down-

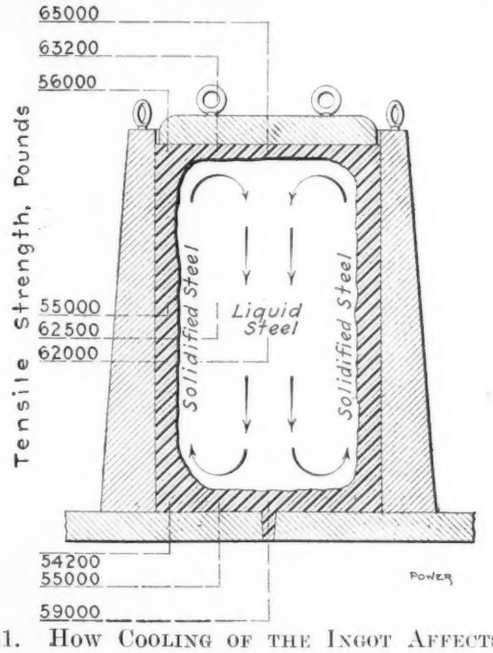


FIG. 11. HOW COOLING OF THE INGOT AFFECTS THE TENSILE STRENGTH

ward, describing an arc. This process causes the plate to be pressed down over the die without kinking, thus securing a uniform curvature. The head is again heated locally preparatory to being fitted with a manhole flange and cover.

IMPERFECTIONS IN THE INGOTS

As the steel cools in the molds a steadily thickening wall of solidified metal forms at the sides of the mold. A current of gas bubbles rises next to the solidified wall while a downward current is created in the center of the liquid metal. This thoroughly mixes the carbon and other hardening elements in the liquid portion, but much of these elements are expelled from the solidifying wall, consequently the liquid portion continually gains in these elements. This action is shown in Fig. 11.

Eventually the metal reaches a temperature where it becomes plastic, preventing gas formation or currents. The segregation of the hardening elements ceases and the metal inclosed by the zone of gas bubbles solidifies in a mass of comparatively uniform character.

The test pieces, previously mentioned, are usually cut

from shearings from the edges of the plates and therefore represent the metal which was part of the solified wall in the cooling ingot, and which is much softer than the metal in the center of the plate.

For carrying high pressures, a plate of high tensile strength is usually specified, and due to the conditions of manufacture, this often results in the use of material so hard in its interior parts as to suffer distress in working to shape. This reduces the actual factor of safety allowed in the finished boiler. To prevent trouble arising from the above conditions, some authorities recommend that ductility be introduced as a factor in conjunction with tensile strength to determine the allowable working stresses so that a steel of lower tensile may be used, if it shows a corresponding increase in ductility.

The writer expresses thanks to Charles L. Huston, vice-president of the Lukens Iron & Steel Co., Coatesville, Penn., for his kindness in showing him through the works and enabling him to obtain the information contained in the article.

Adaptation of Boiler to Available Coal*

By Henry Kreisinger and Walter T. Ray

SYNOPSIS—Description and summary of tests showing the economic effect of changing the baffle arrangement in a horizontal water-tube boiler for use with coals of different characteristics. The tests clearly show the advantage of giving the gases plenty of room in which to burn.

The coals of the New River and Pocahontas fields differ considerably from those of Virginia and still more from those to the southwest, in that the first-mentioned contain about 20 per cent. of volatile matter and the remainder 30 per cent. and more. In addition, the oxygen content is low, so that the volatile combustibles run high. Coals high in volatile matter and low in oxygen need plenty of room in which to burn and the high rate of

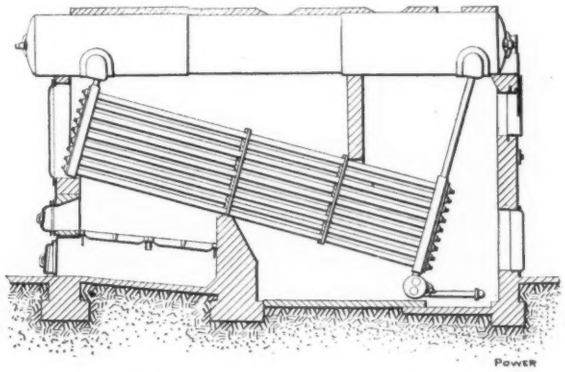


Fig. 1. The Test Boiler with Vertical Baffles

combustion obtainable on a comparatively small grate surface renders such coals desirable when working boiler investments at a high rate. That is to say, the fixed carbon residuums of all coals burn on grates at about the same rates under the same conditions of draft, etc., and any burning of volatile matter in the space above and beyond the fuel bed means so much additional capacity or increased rate of steam production.

Object of Tests

The object of the tests herein described was to determine whether by baffling the boiler horizontally, thereby obtaining a larger combustion space in the furnace, high-volatile coal could be burned with good results and, at the same time, to determine whether, with the horizontal baffle, Pocahontas coal could be burned as economically as with the standard vertical baffle.

Two kinds of coal were used in the tests, Pocahontas and Clinchfield. The Pocahontas coal was from Mercer

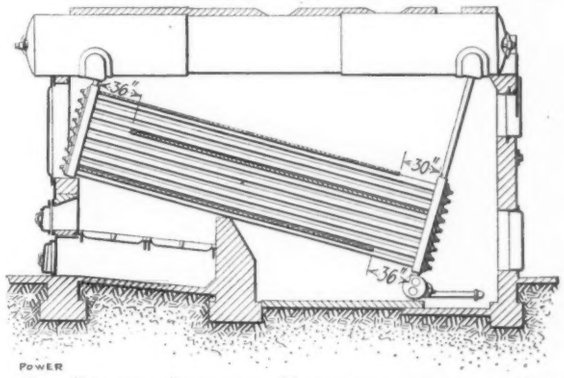


Fig. 2. Boiler Baffled Horizontally for Second Series

County, W. Va., and the Clinchfield coal was from Dante, Va. All coal used in the tests was straight run-of-mine.

Scope of Tests

The tests were made in three series: The first consisted of seven tests, with the boiler baffled vertically as installed by the maker. The location of the baffles and the principal features of the boiler are shown in Fig. 1.

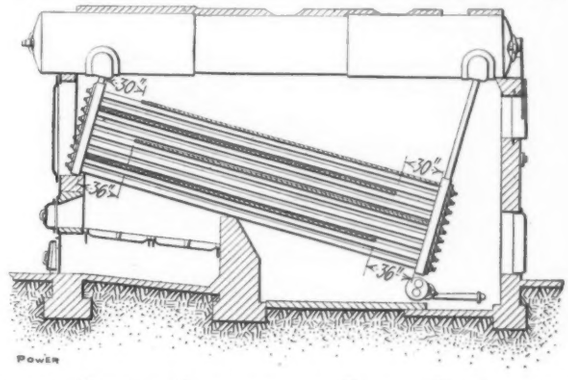


Fig. 3. Boiler Baffled for Three Passes among Tubes

Four tests of this series were made with Clinchfield coal and three with Pocahontas.

The second series consisted of seven tests with the same boiler baffled horizontally in such a way that the space

*Abstract of paper presented to Western Society of Engineers, Chicago, June 2.

beyond the bridge-wall was used as a combustion chamber, the burning gases passing lengthwise, first under the boiler and then twice among the tubes and out through the breeching. The heating surface of the drums was not used with this baffling. The arrangement of the baffles and the path of the gases are shown in Fig. 2. Three of these tests were made with Pocahontas coal and four with Clinchfield coal.

The third series, consisting of five tests, was made with the same boiler baffled horizontally in such a way that the gases passed lengthwise under the boiler as in the second series, then three times among the tubes and finally under the steam drums and out through the breeching. The arrangement of the baffles and the path of gases are shown in Fig. 3. Three tests of this series were made with Clinchfield coal, and two with Pocahontas.

Method of Conducting the Tests

All 19 tests were run under the actual operating conditions of the plant. Usually the tests were begun in the morning when the work at the mill was started and were run through the day (with a 30-min. stop at noon) until 6 o'clock in the evening, when the mill was shut down. At noon the main engine was stopped and there was no demand for steam for about 30 min. During this period the chimney damper was closed. During the tests all coal burned was carefully weighed in a wheelbarrow and the water used in the boiler was measured in a special tank and fed with an injector into the test boiler. The temperature of the feed water was determined in the measuring tank, inasmuch as the water in the suction tank was always hotter on account of the overflow from the injector. The temperature of the outside and inside air, as well as that of the escaping flue gases, was determined. In most of the tests samples of the flue gases were collected and analyzed in an Orsat apparatus. Records of steam pressure and drafts were also kept. These records made it possible to compute the results accurately and express them in pounds of water evaporated per pound of coal. During each test the blowoff piping was disconnected and the amount of leakage measured.

In starting and stopping the tests, a modification of the "alternate method" was used. The fire was cleaned either early in the evening or at about 4 o'clock in the morning; it was then banked and left in that condition until about 5:30 o'clock. At that time the banked coal was spread over the grate and more fresh coal was fired two or three times. Before starting, the firing was suspended for 15 or 20 min. so as to have a thin uniform layer of hot coke on the grate.

When starting the tests the fuel bed was carefully leveled and its thickness measured by dipping into it the prongs of the rake and noticing to what depth the prongs sank into the fuel. The thickness of the fuel bed when the test was started was usually about 2 in. or even less. The object of starting with a thin fire was to reduce the error in estimating the thickness of the bed. The height of water in the gage-glass and in the suction tank was measured and recorded.

When closing the tests the fire was burned down to the same thickness as at the start. The thickness in this case was measured above the layer of clinker and ash. Also at this time the water in the gage-glass was brought as nearly as practicable to the same height as when the test was started. In case the fuel bed was burned down to the right thickness before the water in the gage could be brought to the same level as it was at the start, the test was closed and corrections were made for the difference in water level.

The first was not cleaned before closing the test for two reasons, namely: In the regular operation of the plant the fires were never cleaned before the end of the day's run, and it was desirable to make the tests under as nearly regular operating conditions as possible. It would have been difficult to keep up the steam pressure if the fire had been cleaned while the mill engine was running.

Soon after starting each test the ashpit was cleaned and the fire was run all day without removing any clinker from the furnace or any ashes from the ashpit. About half an hour before closing the test the ash from the ashpit was removed, weighed and charged to the test. About 10 min. after closing the test, the fire was cleaned and all the refuse pulled out from the furnace was weighed and also charged to the test. Ordinarily, when no test was run, the fire was not cleaned until about 4 o'clock in the morning.

As the coal used in the tests was weighed, a shovelful was taken from each wheelbarrow for a sample. The sample thus collected was carefully quartered and sent

TABLE I. CHIEF DIMENSIONS OF TEST BOILER

Type of boiler	horizontal water tube
Capacity as rated by builders, boiler horsepower	250
Number of horizontal rows of tubes	9
Number of tubes in each horizontal row	14
Total number of tubes in boiler	126
Diameter of tubes, in.	4
Length of tubes, ft.	18
Number of steam drums	2
Length of steam drums, ft.	20.3
Diameter of steam drums, in.	36
Water heating surface of tubes, sq.ft.	2381
Approximate water-heating surface of drums, sq.ft.	165
Furnace	
Width of grate, in.	96
Depth of grate, in.	72
Height of bridge-wall, in.	20
Kind of Grate	shaking
Approximate width of air spaces, in.	⅜
Approximate percentage of air spaces	30
Total grate area, sq.ft.	48
Stack	
Diameter of steel stack, in.	48
Height of stack, ft.	80
Approximate length of steel breeching, ft.	10
Size of steel breeching, ft.	4x4
Gas Passages	
Length of gas path among boiler tubes with standard three-pass vertical baffling, ft.	13.5
Length of gas path among boiler tubes with two-pass horizontal baffling, ft.	30.0
Length of gas path among boiler tubes with three-pass horizontal baffling, ft.	45.0
Clear cross-section of gas passages of two-pass horizontally baffled boiler	
Over bridge-wall, sq.ft.	8.1
First pass, sq.ft.	14.0
Second pass, sq.ft.	8.4
Clear cross-section of gas passages of three-pass horizontally baffled boiler	
Over bridge-wall, sq.ft.	10.9
First pass, sq.ft.	8.4
Second pass, sq.ft.	5.6
Third pass, sq.ft.	5.6

to a chemical laboratory for analysis. The average of these analyses for each series of tests is given in the table of results.

The boiler used in the tests was one of three similar boilers in the plant and its principal dimensions are given in Table 1. It was set by itself and provided with its own steel stack. The stack was placed outside of the boiler room on a brick foundation and connected with the boiler by a horizontal steel breeching 4x4 ft. in cross-section. The furnace was equipped with a rocking grate.

Summary of Test Data and Results

Table 2 gives the average of all data and the calculated results of the 19 tests. The calculations were made according to the rules given in the Code for Testing Steam Boilers of the American Society of Mechanical Engineers.

TABLE 2. RESULTS OF 19 TESTS

	Standard Original Baffling							Horizontal Two-Pass Baffles							Horizontal Three-Pass Baffles					
Test number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	
Kind of coal*	Pocahontas	Pocahontas	Clinchfield	Clinchfield	Clinchfield	Pocahontas	Pocahontas	Pocahontas	Pocahontas	Pocahontas	Clinchfield	Clinchfield	Clinchfield	Pocahontas	Clinchfield	Clinchfield	Clinchfield	Pocahontas	Pocahontas	
Date of test	Mar. 5	Mar. 6	Mar. 18	Mar. 19	Mar. 20	Mar. 21	Mar. 22	May 7	May 8	May 9	May 14	May 15	May 16	May 17	Aug. 29	Aug. 30	Sept. 2	Sept. 3	Sept. 4	
Duration of test, hours	5.08	10.25	5.91	11.25	11.33	11.57	11.88	11.00	11.00	11.08	10.58	11.00	10.88	11.08	10.83	10.25	10.83	10.83	9.58	
Steam pressure by gage, lb	140	140	140	140	143	145	145	145	145	146	146	146	146	146	142	140	145	145	145	
Draft in breeching, in. of water	1.0	1.0	1.0	1	1	1	1	1¼	1¼	1¼	1¼	1¼	1¼	1¼	.....	1	1¼	1¼	1¼	
Draft in furnace, in. of water	1	1	1	1	1	1	1	1	1	1	1	1	1	1	.....	1	1	1	1	
Temperature of external air, deg. F	42	37	74	68	81	80	56	75	75	75	75	65	72	66	.....	.....	100	.....	.....	
Temperature of fireroom, deg. F	54	52	80	75	88	85	71	85	92	92	85	75	82	76	94	98	105	104	98	
Temperature of steam, deg. F	361	361	361	361	362	363	363	363	363	363	363	363	363	363	362	362	363	363	363	
Temperature of feed water, deg. F	79	73	78	79	84	90	86	95	98	98	90	90	92	87	98	98	95	98	98	
Temperature of chimney gases, deg. F	584	610	519	547	615	618	606	485	522	541	588	543	533	550	507	501	503	490	486	
Coal over 4-in. screen, per cent	.....	.....	55	.....	.....	25	25	15	20	20	35	35	35	.....	40	.....	.....	.....	.....	
Coal through 1-in. screen, per cent	.....	.....	75	.....	40	50	.....	60	55	50	30	25	30	.....	25	.....	.....	.....	.....	
Weight of coal fired, lb	5356	13,508	6184	12,325	13,383	14,404	12,982	11,502	12,000	12,600	13,500	14,100	13,950	13,800	11,100	10,140	11,700	11,300	9405	
Total ash and refuse, lb	458	710	118	758	987	1039	693	539	744	820	1040	690	1114	873	952	.....	762	858	.....	
Per cent. of clinker in refuse	.....	.....	.....	59	52	44	60	67	65	70	53	.....	57	55	50	.....	55	46	.....	
Coal consumed per hour, lb	1054	1317	1047	1095	1181	1245	1092	1046	1090	1137	1276	1282	1281	1245	1025	988	1080	1043	985	
Total weight of water fed to boiler, lb	22.0	27.4	21.8	22.8	24.6	26.0	22.8	21.8	22.7	23.7	26.6	26.7	26.7	26.0	21.3	20.5	22.5	21.7	20.2	
Factor of evaporation	44,159	101,238	48,465	90,468	98,007	115,739	104,469	99,885	104,000	106,373	108,265	117,817	113,802	115,504	93,287	88,236	99,153	101,470	82,042	
Equivalent water fed to boiler, lb	1.187	1.193	1.189	1.188	1.183	1.177	1.181	1.172	1.169	1.169	1.177	1.177	1.174	1.180	1.168	1.168	1.172	1.167	1.168	
Equivalent evaporation per hr., lb	52,414	120,776	57,624	107,475	115,942	136,224	123,378	117,065	121,576	124,350	127,427	138,671	133,603	136,295	108,866	103,059	116,207	118,415	95,815	
Horsepower developed	10,317	11,783	9767	9553	10,233	11,774	10,385	10,462	11,052	11,222	12,044	12,606	12,279	12,300	10,052	10,054	10,730	10,934	10,001	
Percentage of builders' rated horsepower developed	299	341	283	276	297	341	301	308	320	326	349	365	356	356	291	291	311	317	290	
Water evap. under actual conditions per lb. of coal fired, lb	119	136	113	111	119	136	120	123	128	130	139	149	142	142	116	116	124	127	116	
Equivalent evaporation per lb. of coal as fired, lb	8.25	7.48	7.83	7.34	8.32	8.03	8.05	8.68	8.67	8.44	8.02	8.35	8.16	8.37	8.40	8.70	8.47	8.97	8.70	
Average thickness of fuel bed, in	9.78	8.94	9.32	8.72	8.66	9.45	9.5	10.18	10.13	9.87	9.44	9.83	9.57	9.87	9.81	10.16	9.93	10.48	10.18	
Average per cent. of CO_2 in flue gases	8	8	6	6	6	8	7	7	7	8	6	6	6	8	6	6	6	7	7	
Average per cent. of O in flue gases	7.3	8.8	7.2	6.54	7.7	8.89	7.3	7.2	7.5	8.2	7.76	9.3	8.85	10.8	9.0	9.2	.....	.....	.....	
Average per cent. of CO in flue gases	.....	.....	.....	.....	11.2	10.63	12.5	11.5	11.7	11.26	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Maximum per cent. of CO in flue gases	.....	.....	.....	.....	0.45	0.16	0.15	0.16	0.15	0.2	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Number of samples analyzed	.....	.....	.....	.....	2.2	0.4	0.6	0.4	0.6	0.4	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Air used per lb. of carbon, lb	.....	.....	.....	.....	23	26	25	18	28	28	.....	19	16	19	.....	.....	.....	.....	.....	
	.....	.....	.....	.....	30.3	27.6	32.6	33.5	32.4	29.5	.....	26.2	26.7	.....	.....	.....	.....	.....	.....	

AVERAGE COMPOSITION OF COALS

	Moisture Per Cent.	Ash Per Cent.	Vol. Per Cent.	Fixed Carbon Per Cent.	B.t.u.	Moisture Per Cent.	Ash Per Cent.	Vol. Per Cent.	Fixed Carbon Per Cent.	B.t.u.	Moisture Per Cent.	Ash Per Cent.	Vol. Per Cent.	Fixed Carbon Per Cent.	B.t.u.
Pocahontas	0.62	4.9	17.12	77.36	14,828	.....	4.72	.....	.....	15,050	1.12	5.5	15.76	77.62	14,731
Clinchfield	0.77	7.9	32.00	59.33	14,122	.....	10.26	.....	.....	13,801	0.98	9.85	29.00	60.14	13,750

* Run-of-mine.

Method of Firing

In all the tests a modification of the spreading method of firing was used. When firing, the coal was thrown on the thin spots in the fuel bed, omitting the high places. Coal was fired in small quantities at short intervals. By this method it was possible to keep the fuel bed uniformly thick all over the grate without the use of a rake or other fire tool. This method of firing was particularly successful with the Clinchfield coal. Most of the tests with the Clinchfield coal were run without using the rake at all during the day.

Behavior of the Coals on the Grate

The Pocahontas coal caked considerably. Perhaps a large part of this caking property was due to the fact that the coal contained a high percentage of slack. The freshly fired coal fused and formed a crust on the surface of the fuel bed. This crust cracked in some places, and through the cracks air passed into the furnace. When firing, effort was made to put the coal into the cracks of the fuel bed. By this method it was possible to keep the bed in good condition from one to three hours without using the rake. When the fuel bed became too uneven, the crust was broken and the fuel was leveled with a rake. When the coal contained more lumps, there was less trouble from the formation of crust.

The Pocahontas coal did not clinker. At the end of a day's run the refuse pulled out of the furnace consisted of large pieces of free ashes. Smaller pieces of ashes were removed from the fuel bed by rocking the grate two or three times a day.

Part of the Clinchfield coal was lumpy and burned freely. Usually it was possible to run the fire through the day without using the rake. The coal caked very little but clinkered rather badly. The clinkers were, no doubt, partly responsible for the low capacity obtained in the first series of tests. When the fire was cleaned after the close of each test, the clinkers were pulled out of the furnace with difficulty. The clinker formed in one large sheet over the entire grate and adhered to the side walls and the bridge-wall. This clinkering property was the main objection the men connected with the operation of the plant had to this grade of Clinchfield coal. The rocking of the grate gave no relief from clinker.

The balance of the Clinchfield coal looked much like the first-mentioned lot and possessed all of its properties except that it did not clinker. In composition, however, it was not as good. There was a considerable quantity of impurities in it which made the ash content 2 or 3 per cent. higher than that of the other, reducing the heat value by the same amount. However, the fact that the coal did not clinker made it much the better of the two grades for this particular plant. By shaking the grate

three or four times a day the fuel bed was kept in good condition. The rake was usually not used at all. After the close of the test when the fire was cleaned, practically no clinker was found on the grate. The refuse consisted of large pieces of loose ash which could be removed with ease.

It should be remembered that during the tests the boiler was run considerably above its rated capacity all the time. During the regular operation, the boilers would not be run above their rated capacity and, perhaps, most of the time they would be operated below it. It is

TABLE 3. SUMMARY OF TEST RESULTS

	Standard Original Baffling		Boiler with Two Horizontal Passes		Boiler with Three Horizontal Passes	
	Pocahontas Coal	Clinchfield Coal	Pocahontas Coal	Clinch field Coal	Pocahontas Coal	Clinchfield Coal
	Average of four tests	Average of three tests	Average of four tests	Average of three tests	Average of two tests	Average of three tests
Pounds of water evaporated under actual conditions per lb. of coal as fired	7.95	7.49	8.54	8.18	8.83	8.52
Equivalent evaporation per lb. of coal as fired, lb.	9.42	8.90	9.92	9.61	10.33	9.97
Average hp. developed	320	285	335	357	303*	298*
Maximum hp. developed	341	297	355	365	317	311
B.t.u. per lb. of dry coal	14,828	14,122	15,050	13,801	14,731	13,750
Ash, per cent	4.9	7.9	4.72	10.26	5.5	9.85
Approximate efficiency of boiler and furnace, per cent	61.3	60.9	63.6	67.2	67.7	69.9

*Note: On the test with three horizontal passes, higher capacity could have been developed but the feed water was too hot and the injector would not feed it fast enough into the boiler.

high efficiency. In the horizontal three-pass boiler the draft over the fire is considerably reduced; hence, there is less chance of drawing too much air into the furnace. Therefore, with careless firing, the difference in efficiency in favor of the three-pass horizontal baffle is much greater than with careful firing. In other words, the horizontally baffled three-pass boiler is more nearly proof against careless firing and manipulation.

Conclusions

In Table 3 is given a summary of the results of the tests. The preceding summary of results shows conclusively that much better results can be obtained with Clinchfield coal when the boiler is baffled horizontally. There is also a marked improvement in the results in favor of the horizontal baffling when Pocahontas coal is used as fuel. The horizontal three-pass baffling gives the highest evaporation; the horizontal two-pass baffling gives the highest horsepower developed during tests.

With the two-pass horizontal baffling better evaporation and higher horsepower can be obtained with Clinchfield than with Pocahontas coal and the standard vertical baffling.

Discussion

E. A. Fessenden: The percentages of loss to the stack shown in Table 4, which I have compiled to bring out more clearly some points of comparison between the different baffling arrangements, were estimated by the following approximate method:

TABLE 4. SHOWING POINTS OF COMPARISON BETWEEN DIFFERENT BAFFLE ARRANGEMENTS

Coal	Baffling	Test No.	Draft Pressures Inches of Water: In Breeching	In Furnace	Loss through Boiler	Temperatures Deg. F.: Chimney	Fire Room	Difference	Per Cent. CO_2	Per Cent. Excess Air	Lb. Air per Lb. Combustible (Assuming Chemical Requirement Equals 11 Lb.)	Loss to Stack B.t.u. per Lb. Combustible	Per Cent. Loss to Stack	Efficiency (Over All)	Boiler Efficiency (1—Stack Losses)
Pocahontas	Original Vertical	1	1.00	0.38	0.62	584	54	530	7.3	151	27.6	3640	23.2	64.0	0.833
		2	1.00	0.44	0.56	610	52	558	8.8	109	23.0	3220	20.5	58.5	0.736
		6	0.88	0.38	0.50	618	85	533	8.89	106	22.7	3030	19.3	61.9	0.766
		7	0.88	0.38	0.50	606	71	535	7.3	151	27.6	3670	23.4	62.2	0.810
															Av. = 0.786
	Two-Pass Horizontal	8	0.69	0.31	0.38	485	85	400	7.2	155	28.1	2790	17.8	65.9	0.802
		9	0.69	0.31	0.38	522	92	430	7.5	146	27.1	2890	18.4	65.6	0.804
		10	0.69	0.31	0.38	541	92	449	8.2	125	24.7	2770	17.7	63.3	0.779
		14	0.81	0.31	0.50	550	76	474	10.8	69	18.6	2230	14.2	63.3	0.739
															Av. = 0.781
	Three-Pass Horizontal	18	0.75	0.19	0.56	490	104	386	....	...	....	....	....	69.1	.....
		19	0.81	0.19	0.62	486	98	388	....	...	....	....	....	67.0	.....
Clinchfield	Original Vertical	3	1.00	0.44	0.56	519	80	439	7.2	155	28.1	3060	19.8	64.0	0.798
		4	0.88	0.44	0.44	547	75	472	6.54	178	30.6	3580	23.1	59.8	0.778
		5	0.88	0.38	0.50	615	88	527	7.7	140	26.4	3470	22.4	59.5	0.767
															Av. = 0.781
	Two-Pass Horizontal	11	0.75	0.31	0.44	588	85	503	7.76	137	26.1	3270	21.1	66.3	0.840
		12	0.81	0.31	0.50	543	75	468	9.5	93	21.2	2490	16.1	69.1	0.823
		13	0.81	0.31	0.50	533	82	451	9.3	97	21.7	2460	15.9	67.3	0.801
															Av. = 0.821
	Three-Pass Horizontal	15	....	....	....	507	94	413	9.0	104	22.5	2330	15.1	69.2	0.815
		16	0.75	0.25	0.50	501	88	403	9.2	100	22.0	2220	14.4	71.6	0.837
		17	0.81	0.19	0.62	503	105	398	....	...	....	....	....	....	.....
															Av. = 0.826

reasonable to expect that under these conditions, the efficiency will be even higher than is shown by the tests.

With the present standard baffling of the boilers, the heat lost with the chimney gases is excessive. During the last series of tests, the writers measured with an anemometer the velocity of air entering the ashpits of the test boiler and also of another boiler, the latter equipped with the standard vertical baffles. It was found that with the test boiler the velocity was about 450 ft. per min.; with the other boiler it was about 800 ft. per min., or nearly twice as much, although only about two-thirds as much coal was being burned under the latter. This velocity measurement showed conclusively that entirely too much air was used in the vertically baffled boiler. The area of the ashpit doors of both boilers is the same.

The aim in the preceding paragraph is to show that high draft over the fire is often misused to draw too much air into the furnace and is in such cases detrimental to

From the ultimate analysis of many different kinds of bituminous coal the per cent. of CO_2 by volume was calculated, assuming complete combustion with different amounts of excess air, and the results plotted as per cent. CO_2 vs. per cent. excess air. The curves for all the coals investigated were practically coincident. The column in Table 4, showing percentage of excess air, is made up by means of these curves. From this the amounts of air per pound of combustible are computed as well as the chimney loss in B.t.u.

It will be noticed that, while the value

$$\frac{\textit{Boiler efficiency}}{1 - \textit{stack losses}}$$

varies somewhat in the individual tests, the averages for the different series are nearly constant, indicating that

the chimney losses exercise the most important influence in improving the efficiency.

The draft loss through the boiler passages is less for the horizontal two-pass baffling than for the original baffling. The number of complete reversals of the gas stream is the same for the two cases, but the two-pass horizontal baffling offers less resistance at the points of reversal. The resistance of the horizontal three-pass baffling is slightly greater than the original baffling. The most striking features of the tests are the low draft losses and the low chimney losses with the two- and three-pass baffling. The lower chimney losses obtained in the tests with the three-pass baffling tends to confirm the opinion expressed by the authors in other published papers that the rate of heat transmission increases with an increase of gas velocity.

R. H. Danforth: The conclusions drawn by the authors agree in a very interesting manner with those I had drawn from data obtained in quite a different line, i.e., the testing of boilers with oil fuel. The authors refer to the action of high-volatile fuels to the effect that in a given boiler with a fixed grate surface the increase in output, other conditions being similar, is approximately proportional to the volatile matter burned.

With oil fuel we have in effect a condition where all the fuel is burned in the combustion space. This should mean that within reasonable limits a given boiler should be able to produce almost any horsepower desired, with approximately uniform efficiency. I have recently received data of two tests on a small-tube, express-type, marine boiler, burning oil of about 19,300 B.t.u. per lb. This boiler was run first at low rating and then at a rating as high as could be obtained, with the following results, which practically prove the above thesis:

	Low Rating	High Rating
Lb. water evaporated per lb. oil	13.86	12.47
Equiv. evap. f. and a., 212 deg. F.	14.69	13.10
Boiler horsepower developed	382	1727
B.t.u. per lb. of oil	19,300	19,300
Approximate efficiency of boiler and furnace	73.8	66.00

O. Monnett: Speaking from my professional viewpoint, the baffling illustrated in Fig. 1 would prove very smoky indeed. In trying to solve the smoke problem in Chicago, we have often been forced to employ the horizontal system of baffling. This often meets with opposition on the grounds of loss of efficiency and capacity. Not only do the present tests show that this objection is baseless, but I have knowledge of hundreds of other tests which prove the same thing; in fact, in many cases, the conditions were markedly improved by the change. Of course, the horizontal arrangement of the baffles usually causes a greater draft loss through the boiler and, hence, the factor of available draft must be considered.

I question whether the drafts reported in Table 2 were actually obtained. In my opinion a 150-ft. or higher stack would be required to give an available draft of 1 in. in the breeching under the conditions mentioned. It seems probable that some error has developed, due to inaccurate draft gage or mistakes in reading.

❖

Purchasers' Tests of Crude Fuel Oil

By W. B. Perkins

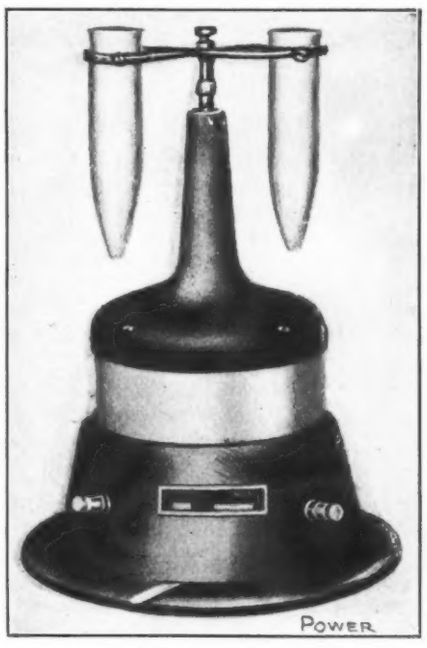
SYNOPSIS—A description of the test methods employed by many central stations using crude fuel oil in the boiler furnaces. The purchase is based on the calorific energy, amount of sulphur, moisture, specific gravity and sediment in the oil.

❖

The method of purchasing crude oil for fuel at a central station where a large quantity is burned each day is based on the calorific energy, sulphur, moisture, bottom sediment in the oil and its specific gravity.

Oil is delivered in cars, pumped from the oil producers, large storage tanks or directly from barges in the harbor. That received in cars is emptied into a long flume leading into a heating and settling tank where practically all the entrained moisture is removed. Just before the work of emptying the cars is started, quart samples are taken from each car at different depths, using a receptacle which may be opened from above the surface of the oil. The percentage of moisture in these samples is immediately obtained with the aid of a centrifuge, a small machine having a high-speed rotating shaft carrying test-tube holders, a view of which is shown in the illustration.

Fifty cubic centimeters of the samples are thoroughly mixed in a graduated test tube with a like amount of gasoline to neutralize the viscosity of the crude oil. The tube is then placed in the motor-operated centrifuge and the machine is run at high speed for approximately 20 min. The centrifugal force exerted upon the mixture throws the heavier parts to the bottom of the test tube. The sand, mud and extremely heavy asphaltic products appear in the point of the tube with the water just above. With the aid of the graduated scale the per cent. of each sample of oil tested is readily observed.



Centrifuge Oil Tester

Any moisture over contract percentage, as shown by the centrifuge, is deducted from the delivery. The specific

gravity, by Baumé scale, and the temperature of the oil when received are also taken, settlement being required if the tests show heavier than 12 Bé. at 60 deg. F. A deduction or addition of 1 deg. Bé. is made for each 20 deg. F. of higher or lower temperature than 60 deg. F. A deduction from the gross quantity of fuel delivered is also made for a higher temperature than 60 deg. F. Samples are also set aside for more complete analysis later.

If the oil is being pumped to the power company's property from barge or storage tank, samples are taken from the pipe line every hour. Each sample is subjected to the centrifuge test, also for temperature and specific gravity. A part of each sample is poured into a small can for future analysis.

Table 1 gives the results obtained from hourly tests.

TABLE I

Time of day	Temp. F.	Specific gravity Bé.	Moisture per cent.	Bottom of sediment per cent.	Moisture and sediment per cent.
7 a.m.	78	18.00	1.0	1.2	2.2
8 a.m.	79	17.75	1.5	1.3	2.8
9 a.m.	77	18.00	0.5	1.0	1.5
10 a.m.	80	18.25	0.7	1.4	2.1
11 a.m.	79	17.50	1.0	1.1	2.1
12 m.	77	18.00	1.2	1.0	2.2
1 p.m.	80	18.30	0.8	0.9	1.7
2 p.m.	78	17.80	0.9	0.8	1.7
3 p.m.	79	18.00	1.0	1.2	2.2
Average	78.5	17.95	0.95	1.1	2.05

From the foregoing the specific gravity at 60 deg. F. equals 17.03 deg. Bé. scale, and the temperature deduction expressed in per cent. is 0.9.

The quantities determined in the laboratory analysis are: Flash point, deg. F.; specific gravity, Bé. and international degrees, at 60 deg. F.; moisture, per cent.; sulphur, per cent.; B.t.u. per pound as received, and B.t.u. per pound dry.

The methods used in determining the above are outlined herewith. For moisture test approximately 50 grams of oil is placed in a 100-c.c. flask communicating with a condenser and finally a carefully graduated test tube. Heat is applied to the flask until all of the moisture has been distilled and a small amount of the lighter oils begins to collect on top of the water in the test tube. The moisture is then read directly.

Generally, the centrifuge test shows a larger percentage of moisture than the distillation method, because the laboratory samples are usually allowed to stand for several days before being analyzed, thereby giving the particles of moisture opportunity to separate themselves from the oil and collect on the bottom of the containing vessel. Repeated shaking apparently does not remedy this fault. For this reason, the results of the centrifuge tests are accepted as being correct in settling claims for deduction for moisture over 2¼ per cent.

For the calorific determination, approximately ½ gram of oil is placed in an Emerson bomb calorimeter, and oxygen applied until a pressure of about 300 lb. is reached in the bomb. The charge is then exploded with a jump spark and the heat units per pound calculated from the rise in temperature of the water bath surrounding the bomb. Knowing the percentage of moisture, the B.t.u. per pound of dry oil may be readily calculated.

For the sulphur determination, the bomb of the calorimeter is opened after the test for heat units has been made and the residue washed out with distilled water. The washings are titrated and barium sulphate is precipitated by adding barium chloride. The per cent. of sulphur is readily calculated when once the barium sulphate is weighed.

A Westphal balance is employed in the laboratory in determining the specific gravity of the fuel oil. The flash point is reached by heating approximately 20 grams of oil in a crucible, surrounded by a sand bath, beneath which is placed a bunsen burner. A jump spark is passed over the surface of the oil every few seconds, after the 100 deg. F. point is passed.

Table 2 contains the results found in making a laboratory analysis of crude fuel oil.

TABLE II

Flash	= 158 deg. F.
Sp. gravity	= 16.8 deg. Bé.; 0.965 International System.
Moisture	= 0.8 per cent.
Sulphur	= 1.3 per cent.
B.t.u. per lb. as received	= 18,265
B.t.u. per lb. dry	= 18,364

The foregoing method of purchasing crude oil for fuel is used by many gas and power companies where liquid fuel is the only heating agency employed. It has given satisfaction in nearly every instance and may be relied upon.

❖

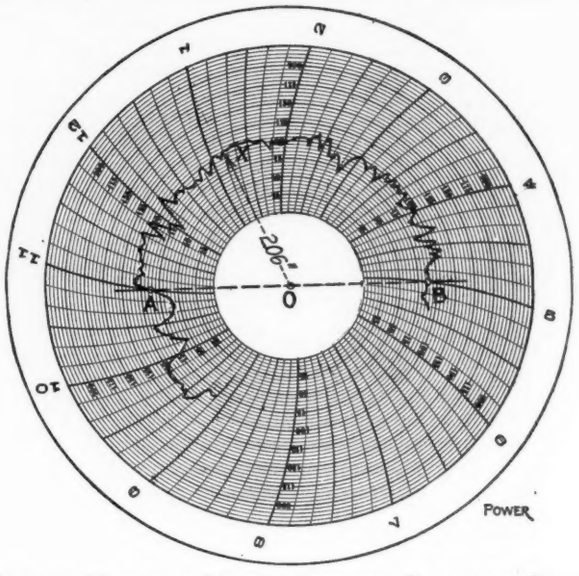
The Polar Planimeter on Circular Charts

By Julian C. Smallwood

SYNOPSIS—How to obtain the average pressure of circular charts with a polar planimeter.

❖

The ordinary polar planimeter may be used to obtain approximately the average value of the quantity shown by a circular chart from a recording instrument. If the diagram is for an entire revolution of the chart, the area in square inches included by the diagram should be found with the planimeter, the gap at the ends of the curve



How to Use the Planimeter on Circular Charts

being closed with radial lines. This area should be divided by 3.1416 and the square root of the quotient obtained. The result is the average height in inches of the curve from the center of the chart. To put this as a formula,

$$\textit{Mean height (in.)} = \sqrt{\frac{area}{3.14}}$$

The quantity wished is now found by noting the value

of a division at a distance from the center of the chart equal to this mean height.

If the diagram is for a period of time less than that corresponding to a full revolution, the formula becomes

$$Mean\ height\ (in.) = \sqrt{\frac{area}{3.14 \times F}}$$

F being the fraction of a complete turn made in the time considered.

Referring to the accompanying chart, suppose it is wished to find the average pressure as shown by the chart between eleven and five o'clock. A line from the points A and B is drawn to the center O. The area included between this line and the recording line is found by the planimeter to be 6.65 sq.in. In describing the recording line between A and B, the chart has made one-half a turn. Therefore, by the second formula,

$$Mean\ height = \sqrt{\frac{6.65}{3.14 \times \frac{1}{2}}} = 2.06\ in.$$

The pressure corresponding to 2.06 in. is found by measuring that distance on any radial as OX, and is 97 lb.

The result is only approximate because it is the square root of the mean of the squares of the radii instead of their arithmetical mean. The distinction between these means may be shown more clearly by the following examples:

8	$8^2 = 64$
9	$9^2 = 81$
10	$10^2 = 100$
11	$11^2 = 121$
12	$12^2 = 144$
$5\overline{)50}$	$5\overline{)510}$
10	102

102 = Mean of the squares;

$\sqrt{102} = 10.09$, the square root of the mean square;

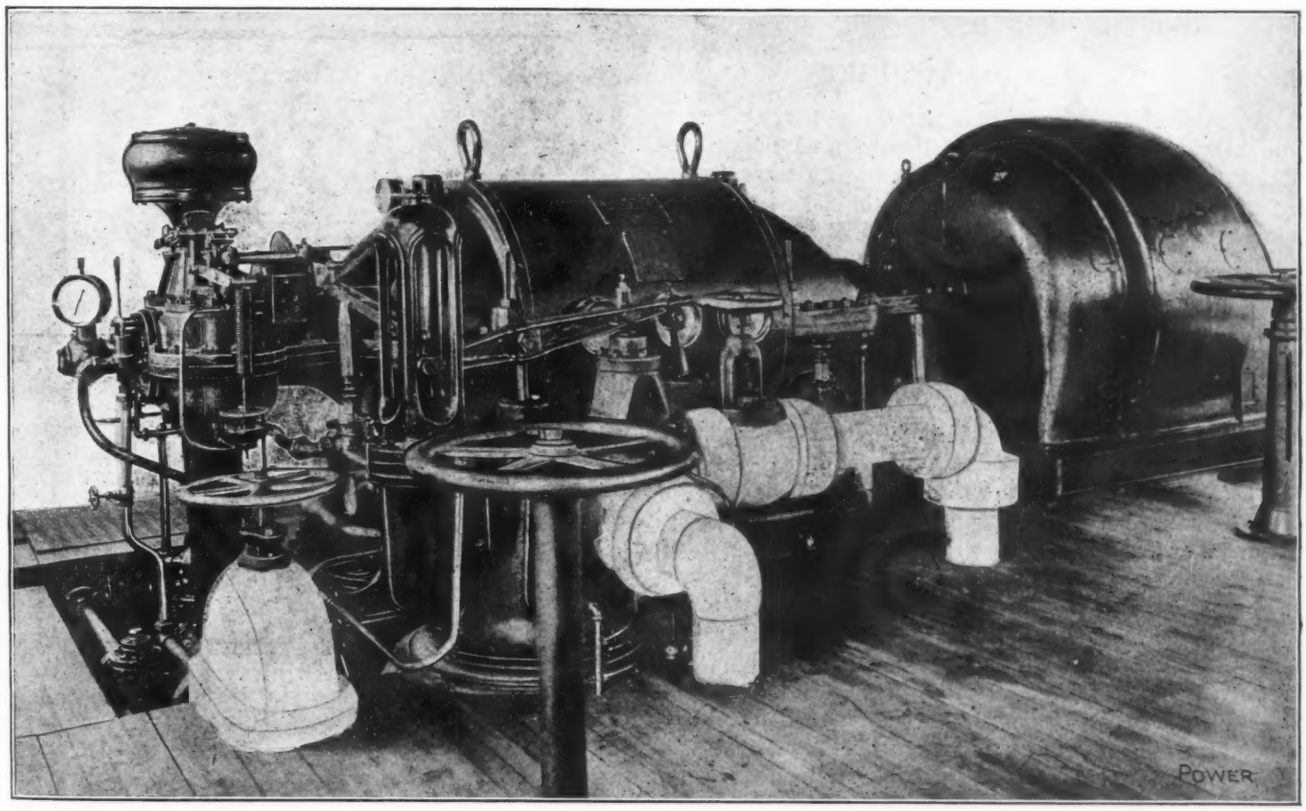
10 is the arithmetical mean.

In this case, the arithmetical mean is about 1 per cent. less than the square root of the mean squares.

Using a theoretically correct averaging instrument on the chart shown, gives a value for the correct average pressure a little less than 97 lb. In general, it may be said that the result with a polar planimeter on such a chart is more accurate, the less is the variation of the quantity averaged; and, except in extreme cases, the error is not greater than 2 per cent.

Saving with Low-Pressure Turbine

An interesting example of the savings which paper mills may effect by using low-pressure turbines, is afforded by the experience of the Smith Paper Co., at Lee, Mass. The primary source of power for the five mills of this company, is the water of the Housatonic River.



Low-Pressure Turbine at Smith Paper Mills

During about one-half of the year the available water is insufficient to develop the required power, and noncondensing steam engines were used to make up the deficit. The exhaust steam from the small engines was used to dry the paper in the various mills, but the exhaust from the seven or eight large engines was entirely wasted. To eliminate this, the company decided to make use of a low-pressure turbine. By replacing five of the reciprocating engines in separate mills by five 200-hp. motors, power is obtained from the exhaust steam at the central mill and is transmitted several miles in each direction at a very small cost. The balance between steam and electrical power in each mill was so fixed that there was

enough exhaust steam available for the heating work without any being blown away to the atmosphere.

The necessary equipment, beside the motors and a transmission line, consisted of a low-pressure Westinghouse turbine, exciter, switchboard and condenser.

The results obtained by the Smith Paper Co. indicate that if operated continuously, the installation would save an amount of coal equivalent in value to its own total cost in a period of about two years. In other words, the investment in the low-pressure turbines and condenser is bringing a return at the rate of 50 per cent. per annum, and allowing for the use of the equipment six months in the year, the return is 25 per cent. If used for a shorter period the return would be proportional. During a recent typical period of three months, for instance, the turbine was operated 62 days, due to shortage of water, and developed 302,000 kw.-hr. in that time. Charged against the other mills to which it is distributed at 1½c. per kw.-hr., this represents a gross earning for the turbine of $4530. The net charge against the machine for that period was $1400, showing a net saving of $3100 for the three months.

Automatic Air Pump

An interesting design of air pump has been operating for some time in the mine of the Pittsburgh & Southwestern Coal Co., Avella, Penn., for removing mine water. It is the invention of Edwin Chamberlin and A. M. Gardner, Avella, Penn., who have applied for a patent on the device, which provides a simple, efficient and automatically operated liquid-elevating apparatus. A vertical sectional view of the apparatus is shown herewith. It consists of a tank adapted to be submerged or partly submerged in the water to be elevated. It is provided with water-inlet valves *A* and *B*. A water-discharge pipe *C* is piped to the bottom of the tank, and a spring-controlled valve *D* regulates the flow of water through the pipe.

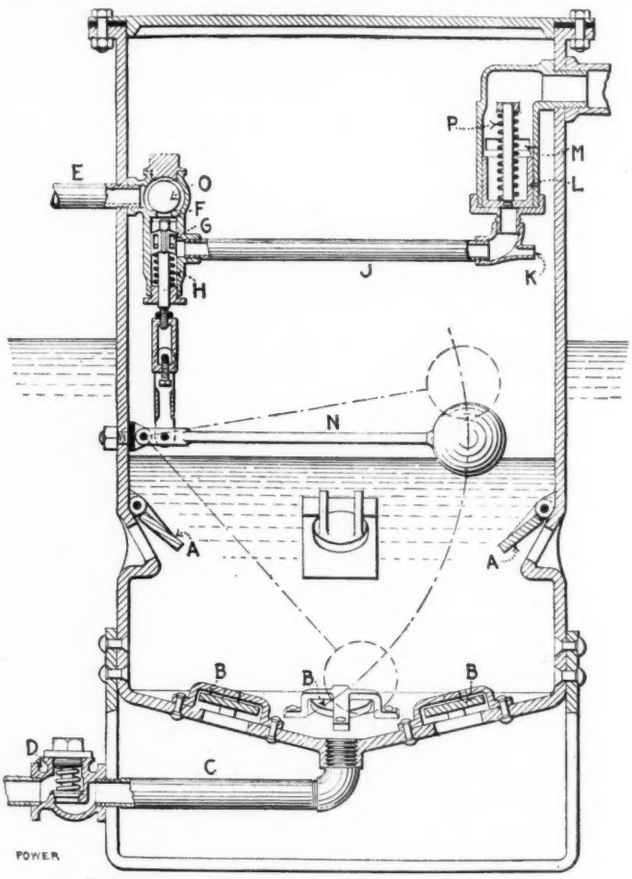
The apparatus is designed for use in connection with compressed air, which enters through the pipe *E*, leading from an air compressor, located at any suitable point, to an air-inlet valve. This mechanism comprises a casing which is fitted with an interior seat *F*, upon which a ball valve seats. The casing is formed with a central bore and is fitted with a valve *G*, the stem of which passes through a plug cap, the latter closing the lower end of the casing and forms a seat for the compression spring *H*, which keeps the valve stem engaged with the ball valve *O* after it has been moved upward by the air-inlet, valve-actuating mechanism.

Located on the opposite side of the tank from the inlet valve is an air-exhaust mechanism connected by a pipe *J*. The exhaust-valve mechanism comprises a casing having a horizontal outlet chamber and a nozzle, the latter being connected with an exhaust-air outlet pipe. The lower end of the casing is capped and connected to the pipe *J*, as shown. The elbow is provided with an opening *K*, through which the compressed air is discharged into the interior of the tank.

The cylinder is provided with a spring-controlled plunger which is made with a stem. As the plunger is raised the stem passes through a guide. Interposed between the guide and the plunger is a spring. The casing is provided with a series of ports so designed that when the piston is in its lowest position the passage of air from the interior of the tank to the air-outlet nozzle is permitted. When the plunger is raised by the compressed air, the air ports are closed, thereby cutting off the escape of air from the interior of the tank.

The air-inlet valve mechanism is actuated by means of a float-controlled mechanism, as shown. By means of the adjusting mechanism connecting the valve stem *H* and the rod *N*, the supply of air may be cut off at any desired position of the float, and thus regulate the quantity of compressed air necessary to effectively operate the apparatus.

Assuming that the water or other liquid has entered the tank to a predetermined level, the air-inlet valve *O*



SECTION THROUGH AUTOMATIC AIR PUMP

is raised from its seat by the valve-actuating mechanism, and compressed air passes from the air-inlet valve casing through the pipe *J* to the exhaust valve. The compressed air raises the plunger *L*, thereby closing the ports *M* and preventing the escape of air from the interior of the tank. Simultaneously with the moving of plunger *L*, the compressed air discharges through the contracted nozzle *K* and, expanding, forces the liquid contents of the tank out through the discharge pipe *C*. The descent of the float draws the valve-operating stem *H* down out of contact with the ball valve *O*, when it drops to its seat and cuts off the supply of air to the tank.

After the air has been cut off, the expansion of the air within the tank will force all the liquid in the tank out through the discharge pipe. After the liquid has been discharged, the pressure within the tank is reduced sufficiently to enable the spring *P* to move the plunger *L* down past the ports *M*, which permits the contained air to es-

cape from the interior of the tank, which then fills with water.

By this arrangement a saving in the quantity of air used is made, because the air introduced prior to cutting off the supply will expand and force the water from the vessel.

This pump when properly installed and adjusted to meet the requirements or work assigned, will begin operation just as soon as air is turned on at the compressor, and will continue to operate until the air is shut off or until the water reaches the desired level of drainage, after which the pump will automatically retain that level, using the air only when there is liquid to be raised.

The adaptability of this pump for raising acids, sulphuric mine water, etc., is evident as the intake and discharge valves are made of alloys that will meet with the requirements of the varying conditions. All the other working parts may be located above the liquid to be pumped.

❋

Economizer Losses Due to Scale

By E. R. Pearce

SYNOPSIS—The author shows that the removal of a little scale from the tubes of an economizer decreased the coal consumption by about 6 per cent. It is pointed out that a handful of soda ash dropped into each tube and that kerosene poured on the surface of the water previous to filling the economizer preparatory to boiling for cleaning, will enable one to easily remove exceedingly hard scale.

❋

Recently, on looking through some test figures, the writer was quite surprised at the low temperature of the economizer-outlet water compared with the sizes of economizers and flue-gas temperatures, especially in one case where the feed should have been fully one hour in passing through the tubes. Readings were then taken on one set containing 192 tubes, the capacity of which is stated by the makers to be 12,000 lb. per hr. The heating surface is 1920 sq.ft. This economizer is smaller for the plant than recommended, but extension in this particular plant is out of the question at present.

The averages of a number of readings are as follows:

Flue gases entering economizer	710 deg. F.	Drop 130 deg. F.
Flue gases leaving economizer	580 deg. F.	
Water entering economizer	156 deg. F.	Rise 79 deg. F.
Water leaving economizer	235 deg. F.	

Approximate weight of water passing per hour, lb. 24,000.
Coal burned per hour, lb. 3287.

After these readings the caps were knocked in and a fairly hard scale exposed, composed of clays, vegetable matters and mill refuses, and varying in thicknesses of from $\frac{3}{16}$ to $\frac{5}{16}$ in. at the top of the tubes to ½ in. at the bottom. After carefully scraping there was still ⅛ in. of hard scale remaining which the hand scrapers would not take off. It was then decided to soften the scale as follows:

The blowdown was closed and about 2 in. of water run into the bottom headers, two handfuls of soda ash were next dropped down each tube, followed by a small quantity of coal oil which was allowed to run down the sides of each tube over the scale, a small quantity of the oil was also dropped on the surface of the water in the bottom, the water was now allowed to flow in very slowly, which in rising caused the oil to make contact with all the scale. After this the damper was cracked to allow a little of the gases to flow through and gradually bring the water to a boil (all windows being open and lights kept away). The boiling was continued from Saturday until Monday morning, water being added from time to time. On Monday the remaining scale was scraped off quite easily, a fair quantity having dropped off during the boiling.

There is one point upon which the writer would advise anyone trying the above to be very careful about, viz., while the economizer is boiling, one end, that is, the end nearest the inlet damper, will be considerably hotter than the outlet, owing to the damper being open but very little, and as the water will not have a good chance to circulate, slugs of water will be shot out of the open tube ends at the hottest point every few minutes, rising several feet, and the reader can take the writer's word for it that this water is highly capable of scalding. After cleaning and boiling, another set of readings was taken, the averages of which are:

Flue gases entering economizer	694 deg. F.	Drop 154 deg. F.
Flue gases leaving economizer	540 deg. F.	
Water entering economizer	156 deg. F.	Rise 136 deg. F.
Water leaving economizer	292 deg. F.	

Approximate weight of water passing per hour, lb. 24,000.
Coal burned per hour, lb. 3088.

From these figures it will be seen that a rise of 136 deg. F. was obtained which is an improvement of 5.5 per cent. on the first set of readings.

During both sets of readings which were taken over a period of ten hours the load was practically constant. A gain of a little over 6 per cent. is shown in the coal consumption.

Considering the amount of water passing through the economizer per hour the heat transferred per square foot of surface is good, amounting to

$$\frac{24{,}000 \times 136}{1920} = 1700 \; B.t.u. \; per \; sq.ft. \; per \; hr.$$

In the other set containing 320 tubes the temperatures were very low, only a little better than is possible with a good open heater. On opening up the economizer the tubes were found to be reduced in water space to less than one-half, in fact, there was only a hole of about 1¼ in. diameter at the bottom ends of many tubes.

❋

The Bridge River Co., a recently incorporated Canadian concern, has applied to the provincial government for water rights aggregating 100,000 ft.-acres in the Lillooet district on Bridge River for developing at least 200,000 hp., at a cost of $8,000,000. A large dam is to be built and the water carried through a ¾-mile tunnel to Seaton Lake, where the power plant will be built. The company has taken into consideration the future requirements of Greater Vancouver and the possibility of electrification of the coast section of the Pacific & Great Eastern Ry., which is to run north from the Pacific coast of British Columbia, to connect with the Grand Trunk Ry. at Fort George. The proposed power line will follow the route of the Pacific & Great Eastern Ry. for about 150 miles. As the power house will be less than 50 miles from the main lines of the Canadian Pacific and the Canadian Northern at Lytton, the projectors hope also to be able to sell motive power to these two roads. Work is expected to begin on this project before the end of this year and will take probably three years to complete.

❋

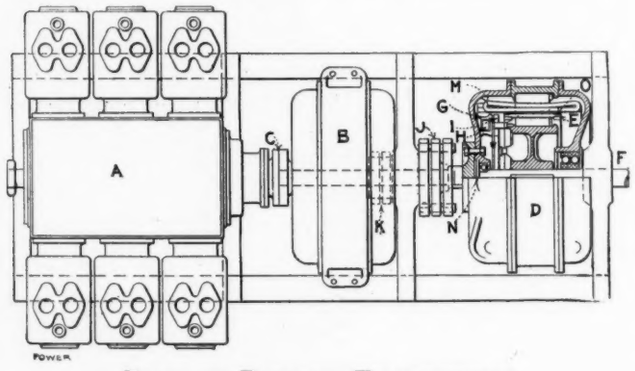
The Manchuria Ry. Co. operates five coal mines, which give employment to 7000 Chinese laborers, who work for 25c. per day. The output is 300 tons for each mine per 24 hours. Though the coal is bituminous, anthracite methods of mining are used, as the seam is too thick (125 ft.) to make bituminous methods practical.—"Coal Age."

ELECTRICAL DEPARTMENT

The "Paragon" System of Electric Drive

By Arthur H. Allen

W. P. Durtnall, the inventor of the "Paragon" engine, described in the Feb. 18 issue, and of the "Paragon" system of propulsion for ships, locomotives, etc., has devised a new and ingenious method of propulsion for motor vehicles in which are embodied the advantages of the gasoline engine and electrical transmission and control. An essential feature of the system is the fact that the engine is always run at its most economical speed; three economical running speeds are provided, and reverse, and a flywheel is dispensed with, its function being filled by the revolving parts of the electrical machines.



Plan of Paragon Transmission

The accompanying illustration shows the arrangement of the mechanism, which consists of a six-cylinder horizontal "Paragon" engine *A*, with ball bearings; a three-phase, four-pole alternator *B*, and a "clutch-motor" *D*. The engine runs at 800 r.p.m. and drives the rotor of the alternator through a coupling *C*, as well as the outer part of the clutch-motor; the inner part of the latter *E*, is a squirrel-cage rotor of the ordinary type, fixed to the shaft *F*, which is carried in journal ball bearings and the centering ball bearing *N*. This shaft is coupled in the usual way to the driving gear, with a simple reversing gear consisting of two bevel wheels always in mesh, one with each side of the driving pinion; a dog clutch mounted on a squared part of the main axle, and operated by a fork and lever, brings either pinion into action, according to the direction of motion required.

Inside the clutch-motor case there is a magnetic clutch, of which half is shown at *G;* this is energized by the exciting coil *H*. When the magnetic clutch is in operation, the engine drives directly on to the shaft *F*. Slip rings are shown at *K*, by means of which the exciting current is conveyed to the revolving field of the alternator. Other slip rings *J* are connected through the hollow shaft with the eight-pole, three-phase winding of the clutch-motor case, which is exactly like the stator of an induction motor, but in this instance is not stationary. The mode of operation is as follows:

The engine is constantly running at, say, 800 r.p.m., and drives the revolving field of the alternator, together with the two sets of slip rings and the outer case of the clutch-motor; assume that the rotation is counter-clockwise. For the first speed, direct current is supplied to the slip rings *K* from a small exciter, not shown. Three-phase current at 25 cycles is taken from the alternator armature and delivered to the slip rings *J*, which are connected to the eight-pole winding *M*. The three-phase connections are such that the magnetic field revolves in a clockwise direction at 400 r.p.m., while the winding revolves at 800 r.p.m. in the counter-clockwise direction, so that the resultant rotation of the magnetic field is counter-clockwise at 400 r.p.m. The squirrel-cage rotor, therefore, starts and runs up to approximately synchronous speed, driving the vehicle at, say, four miles an hour.

The next speed is obtained by switching off the exciting current from the field magnet of the alternator, and putting it by way of one of the slip rings and the frame on the magnetic clutch coil *H*, which connects the engine shaft mechanically with the shaft *F*, so that the vehicle is accelerated to twice the former speed, and runs at eight miles an hour, with the maximum economy—no electrical machine being in operation except the small exciter.

The third speed is given by reversing the three-phase connections, releasing the magnetic clutch and again exciting the alternator; the magnetic field now rotates in the same direction as the engine shaft, and the resultant angular speed of the field is 800 plus 400 = 1200 r.p.m., so that the motor runs up to a speed corresponding to 12 miles an hour.

As stated, no flywheel is required, and, owing to the high speed of rotation and consequently effective cooling, the electrical machines are very light for a given output and heating limit. The efficiency of the transmission is very high, the total weight per horsepower transmitted is low, and the mechanism is comparatively cheap. The speed of the vehicle, of course, depends upon the gearing, the example given being merely illustrative. The engine always runs under economical conditions, and the starting torque is very high.

❋

Welding an Armature Shaft

Some months ago we welded an armature shaft which seemed at first somewhat doubtful of success; but on account of the inability to obtain another armature we tried the experiment. The armature was for a 50-hp. motor running at 1000 r.p.m. The shaft carried a 12-in. pinion, which ran at the high speed of 3150 ft. per min. on the pitch line. As might be expected, the gears are very noisy and wear out frequently, which in turn was responsible for damage to the motor shaft, so that it previously had to be turned from 3½- to 2¾-in. diameter.

The excessive vibration, due to the high gear speed,

ultimately caused crystallization of the shaft and the break at the shoulder. To repair the shaft, we beveled the end of the armature shaft and also the 3⅝-in. diameter block shaft, which was to be welded, starting the weld from the center and being careful not to cause blisters. After allowing it to cool, the shaft was turned down to 3⅜ in. and keyseated (the gear wheel having been bored larger meanwhile). In this way the machine was out of commission slightly over 24 hr. So far the weld has not given any indication of weakness, although the machine has been doing heavier work than before the time of the accident. Of course, the weld may not be quite as strong as the hammered portion of the shaft on account of the coarser grain, but a 3⅜-in. diameter shaft is 80 per cent. stronger than one of 2¾-in. diameter, which was the size which broke.

Where breaks of large cross-section are to be welded by the oxyacetylene process they should be heated by a gas or oil burner before starting to weld, as otherwise the weld will crack upon cooling.

Bellevue, Penn. J. L. KLINDWORTH.

New Line of Westinghouse Motors

The new line of Westinghouse type CS squirrel-cage induction motors possesses several noteworthy features, among which are the extensive use of pressed steel in the construction and rotors with cast-on short-circuiting rings. Pressed steel imparts great mechanical strength and is very uniform in structure; hence a motor of a given weight can be made with more active material than motors of corresponding capacity in cast-iron frames.

In these motors, rolled steel forms the frames of the sizes above 20 hp., the end plates of the smaller sizes (which are of the so called frameless type) and the feet

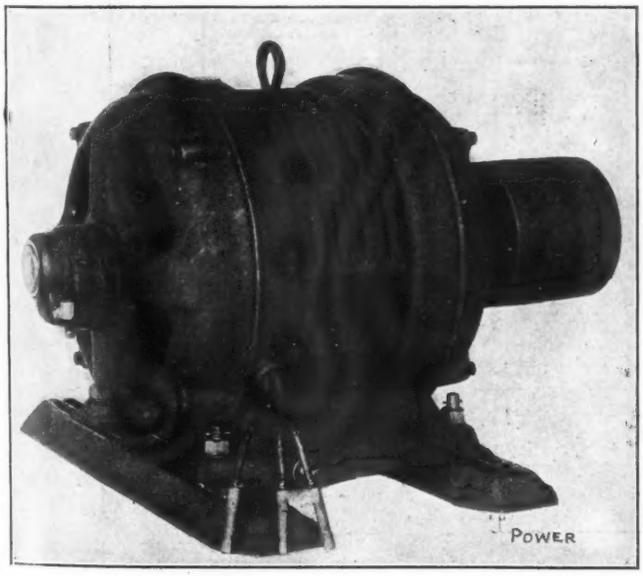


FIG. 1. A 10-HP. MOTOR

and the slide rails of all sizes. Above 5 hp., the form-wound stator coils are laid in open slots.

The rotor construction is especially interesting. In all sizes, the rotor bars are insulated with a special cement which is moisture proof and will withstand a high degree of heat and mechanical stress. In motors above 15 hp., the bars are connected electrically and mechanically by casting the short-circuiting rings around their ends.

The bearings, being the only wearing part, have been designed very liberally. They are protected from dust

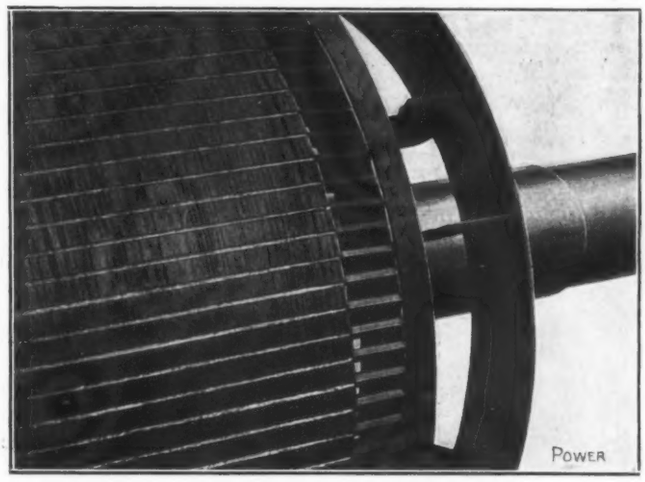


FIG. 2. DETAIL OF ROTOR

by a cap on the front end and by felt washers between metal rings on the pulley end.

The efficiency and power factor are claimed to be high, not only at full loads, but also at fractional loads. This last feature is of special importance because industrial motors generally run at less than full load. These motors are being put on the market in all commercial sizes from 1 to 200 hp.

Care of Storage Batteries

In the article on the "Installation and Care of Storage Batteries" in the July 22 issue, the instructions about taking the battery out of service are not, in the writer's opinion, in accord with present-day practice. The statement in question is that the battery must first be discharged and then the electrolyte removed from the jars and water put into them, after which the battery must be still further discharged and then the water drawn off.

It was formerly the custom to do this, on account of the action on the wood separators, but experience and improved methods of treating the separators have shown that the following method, which is approved by one of the largest battery manufacturers, is better:

When about to lay up the battery, first thoroughly charge it and then siphon off the electrolyte into clean receptacles of glass or earthenware, and as each cell becomes empty, immediately fill it with pure water and allow all of the cells to stand for about fifteen hours, after which the water may be drawn off and the battery may stand indefinitely.

The use of storage batteries has become so common of late that many engineers have them in their plants, and even if a man comes into a plant where there is a battery and is unfamiliar with the operation of the battery, the manufacturer is usually ready to help him with advice and personal aid; and if he makes no important changes without consulting them until he has learned all about the characteristics of the battery he will have no trouble.

East Dedham, Mass. G. H. KIMBALL.

[The discharge method is still advocated by many authorities.—EDITOR.]

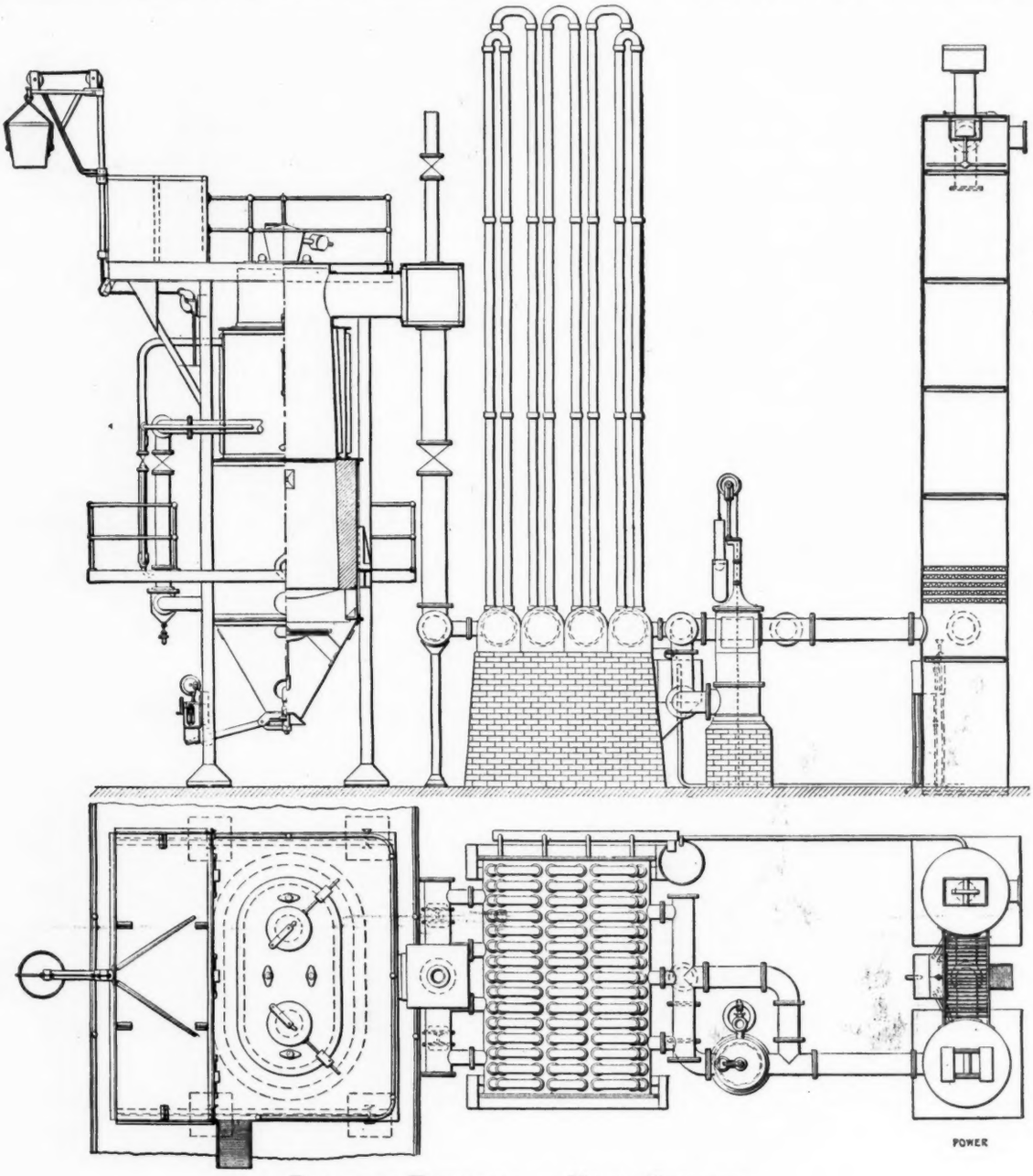
GAS POWER DEPARTMENT

A New Byproduct Recovery Producer

By James A. Seager

During combustion of coal in gas producers in the presence of considerable steam, a large part of the nitrogen content of the fuel enters into combination with the hydrogen of the steam, forming ammonia. The decomposition of ammonia by heat is, however, very easy, and the temperature has to be kept down to prevent it from being wasted.

The method usually adopted to keep the temperature down is to admit to the producer a great excess of steam, this being a wasteful procedure from various points of view. The ammonia has to be recovered by an acid process as any scrubbing plant capable of dealing with the large volume of gas and steam leaving the producer would be excessively large and costly. The ammonia salts obtained from such an acid process, moreover, often have a bad color and the tar obtained is not of the best quality. In addition to all this the development of



Plan and Elevation of Moore Producer

such an excess of steam requires a larger steam-generating plant than would otherwise be necessary.

These disadvantages, therefore, add interest to a new type of water-jacketed producer with byproduct recovery, designed and constructed by the Dowson & Mason Gas Plant Co., Ltd., of Manchester, Eng., an elevation and plan of which is herewith shown. The fundamental principle underlying this new development is the separation of the gas production into three stages in the producer itself. The lowest portion of the producer consists of a region in which a high temperature is maintained, the fuel being treated in a compartment lined with firebrick and here the greater part of the gas and ammonia are generated; the amount of steam admitted is strictly that excess necessary to prevent the temperature rising beyond the proper value.

Above this high-temperature region is a second or intermediate temperature section where the producer is not lined with firebrick but is water-jacketed, and here the gas which has been generated in the lower part of the producer is cooled to prevent decomposition of the ammonia. This cooling process is equivalent to the introduction of a large excess of steam in the older process. It will be seen that in order to insure this cooling effect the internal diameter of the producer which is slightly conical is rather less compared with its height than is usual in ordinary producer practice.

The third region, in which the process is carried a stage further, allows for air cooling; but there is no definite line of demarkation between the second and third regions. The feed of the coal is not intermittent, as in many types of producers, but is continuous through a special gas-tight feeding apparatus, and the ashes are withdrawn by means of two circular-coned tables, one on either side of a grate built up in halves. It will be noticed that the usual water bottom is eliminated.

The water jacket serves as a steam generator supplying most of the steam required for operating the plant. It is stated that a 300-hp. plant is capable of working at 1¼ lb. of coal per brake horsepower-hour and this will evidently yield a good return on the capital invested providing that favorable conditions exist for the disposal of the byproducts.

The producer, as will be seen from the foregoing remarks, possesses advantages over the ordinary recovery producer. The conical shape allows for the expansion of the coal during the coking stage, and facilitates the natural descent of the coal; hence about 50 per cent. more coal is said to be gasified for the same sectional area as compared with the ordinary byproduct recovery producers having a vertical shaft. The double function of the water jacket is also important. It rapidly cools the ascending gases formed in the brickwork portion of the producer, thus preventing the decomposition of the ammonia and it also provides about half the steam required for the saturation of the air blast. This total amount of steam is about one-third to two-fifths of that required for the production of ammonia in ordinary recovery producers (about 80 to 90 lb. of ammonia per ton of coal). The amount of steam decomposed in passing through the producer is approximately 20 per cent. in excess of that decomposed in ordinary recovery producers working at the same blast temperatures. Another feature is that the temperature of the gas in leaving the producer is very low—in the neighborhood of 200 deg. C., which besides improving the efficiency of the producer itself, also simplifies the auxiliary cooling and recovery plant necessary to the process. Moreover, the gas, after the extraction of tar and ammonia, leaves the plant at little above atmospheric temperature, and is practically free from moisture.

The calorific value of the gases, when the plant is being worked under conditions which allow the recovery of from 80 to 90 lb. of ammonia per ton varies from 155 to 160 B.t.u. per cu.ft. The average analysis of the gas obtained may be judged from the following:

CO_2	CO	H_2	CH_4
per cent.	per cent.	per cent.	per cent.
9 to 10	20	20	3

It has been found possible by reducing the quantity of steam, to obtain a gas containing 25 per cent. or more of carbon monoxide, although this gain is at the expense of a reduction in the ammonia yield. On the other hand, where the quality of the gases is of less importance, it is possible to obtain a much greater yield of ammonia than 80 or 90 lb. per ton of coal.

Summarizing the features, it may be pointed out that the claims of this new producer known as the "Moore" type, are that after allowing for producer loss and the heat required for steam raising, the net available quantity of gas is 20 per cent. more than that obtained from ordinary recovery producers. This would make the first cost of the plant less. Moreover, the ground space required per unit is about half that required for the ordinary recovery plants and operating costs are said to be considerably less.

The live-steam requirement calculated on the total coal gasified in the producer amounts to 8.5 per cent. The feeding of the coal is constant and regulated by the rate of ash extraction, the latter in its turn being regulated by the rate of gasification. The tar is extracted after the gas is cooled by passing through air condensers by the well known Plouze and Audouin apparatus and the ammonia is scrubbed out with water from the gas and recovered as ammoniacal liquor. By recovering the ammonia in this form either concentrated ammonia or ammonia salts can be manufactured as required.

To Make German Engines

The American Krupp System-Diesel Engine Co. has been incorporated under the laws of Delaware to manufacture and sell Krupp-Diesel engines. The company has secured the exclusive rights for the United States and its territorial possessions to all inventions, patents, trade marks, etc., of the celebrated German concern, The Fried. Krupp A. G. of Essen, Magdeburg and Kiel, in so far as the same relate to oil engines and especially to the Diesel engine.

There is no falling off in the building of large gas engines in Germany. Thyssen, at Mulheim, has 60 on order, none of which is under 2500 hp., and is turning out one a week. The Augsberg Nürnberg Maschinenfabrik has over 700,000 hp. of big engines running on blast-furnace gas, and reports no falling off in orders for such engines. The greater cylinder diameter is 1400 mm. (55 in.), and the largest engine 6000 hp. in four cylinders.

REFRIGERATION DEPARTMENT

Corrosion in Refrigerating Systems

By Morgan B. Smith

During the past eight years the writer has been called upon to investigate many cases of corrosion in refrigerating systems during which time he has been able to isolate certain factors which exert an accelerating force upon that natural tendency of metal, especially iron, to return to the original condition of nature through the process of corrosion or oxidation.

One of the greatest factors entering into this action is that force set up between electrically dissimilar metals known as auto-electrolysis, or, in the older diction, galvanic action.

In the first place it seems best to give a short table, showing the relationship which exists between those metals commonly entering into the make-up of refrigerating system, in order that the action which ensues between electrically dissimilar metals may be understood. In combinations of such metals it is always the positive metal which is attacked and so eventually destroyed. In the following table the most positive metal is given first. Each metal is positive to the one following it and negative toward the one proceding it, as a rule:

1. Aluminum	5. Iron	9. Copper	13. Phosphorus
2. Chromium	6. Nickel	10. Hydrogen	14. Sulphur
3. Manganese	7. Lead	11. Silicon	15. Chlorine
4. Zinc	8. Tin	12. Carbon	16. Oxygen

From this table may be derived the electrolytic relation between any two of the metals given. Simple contact of any two metals in this series will generate an electromotive force (e.m.f.). The greater the separation of the two metals in this table the greater will be the e.m.f. set up between them. In the presence of moisture or an electrolyte auto-electrolysis or galvanic action will be set up and the positive metal destroyed.

Of those elements noted in the table, iron, copper, copper-tin (brass) and zinc probably play the larger part in refrigerating plants. The other elements given, with the possible exception of aluminum which in the future is sure to come into more general use in refrigerating plants, are usually present as impurities in the metals used in the construction of such apparatus.

In the matter of combinations of dissimilar metals, not merely the union of separate pieces of unlike metals, such as iron with copper or iron with brass, etc., but also the union which exists between metals and the impurities in those metals, as, for example, that contact which exists between iron and carbon, iron and phosphorus, iron and sulphur, iron and mill-scale, etc.

It is apparent, therefore, that not merely must the union of separate pieces of unlike metals and the union of the metals with their impurities be considered, but also the state in which those impurities exist in the metals.

As a matter of fact, there are only two conditions which need be considered, namely, that of true alloys in which the original metal and the alloyed metal have each lost their individual identity and so act as one metal, in which case, strictly speaking, the added metal is not spoken of as an impurity; and, secondly, that condition in which metals other than the basic metal are present in mere mechanical contact with the basic metal.

The iron-copper alloys represent the first condition well and cast iron the second. In the case of the iron-copper alloys, both the iron and the copper have lost their identity as such, whereas in the case of cast iron, or for that matter, wrought or malleable iron, in a somewhat lesser degree, the iron still retains its identity as such; likewise the impurities in it, such as carbon, silicon, phosphorus, sulphur, etc.

In the case of the alloys the metals composing them are no longer free to act upon one another; whereas in the case of cast iron, the basic metal and the impurities are still free to act upon each other, setting up within the metal local zones of electrolytic action where corrosion takes place more or less rapidly at the expense of the iron.

These local electrolytic centers also arise around particles of mill-scale (oxide of the metal) which acts electro-negatively toward the metal and so hastens the destruction of the metal itself.

It is now apparent that the distribution of these impurities in the basic metal will have much to do with the character of the corrosion, determining to a large degree whether the corrosion is to take place locally or in general throughout the metal. If the impurities are evenly distributed in the basic metal, corrosion will take place uniformly, resulting in an even wearing away of the metal, likely to give a fair length of life.

If, on the other hand, the impurities are segregated, or gathered together, in fairly well defined masses, corrosion will take place at these points principally, resulting in pitting or grooving of the metal, in which case the piece of metal will fail at these points long before the real life of the metal has been reached.

It is, therefore, safe to conclude that so far as possible combinations of dissimilar metals should be avoided; that metals of the highest degree of purity should be used and that metals showing the least degree of segregation of their impurities should be selected. Likewise, that the alloys offer a possible means of avoiding local or auto-electrolysis in metals.

In practice during the past eight years many instances of obviously bad practice have been noted, among which are the following specific instances:

1. Brass valves joined with wrought-iron nipples or pipe. The iron is attacked in this case.

2. Cast-iron fittings joined with wrought-iron nipples or pipe. The wrought iron is usually attacked more rapidly than the cast iron, although it too is eventually destroyed.

3. Brass glands, etc., in cast-iron-bodied pumps. In this case the iron is eventually destroyed.

4. Galvanized iron joined with brass valves. The iron is here destroyed rapidly, even though the iron has

been re-galvanized after threading, for the zinc is even more strongly electro-positive toward brass than is iron.

5. In many cases the use of galvanized-iron piping where there is much moisture and a free circulation of air has proved to be bad practice, especially if the quality is not the best, where there are many pin holes in the zinc coating. The zone of protection afforded iron by zinc in galvanized iron is comparatively restricted and, inasmuch as this protection is given at the expense of the zinc, it is obvious that the more iron is exposed the faster will be the destruction of the zinc, zinc being electro-positive toward iron.

6. Steel piping joined with cast-iron fittings. In which case the steel piping or nipples will be attacked first, the cast iron also showing attack.

7. Steel piping joined with brass valves or unions. In which case the steel is attacked vigorously.

8. Copper vessels to which are attached iron or steel pipes or fittings, as in some breweries. The iron again is attacked.

9. Iron or copper piping made up with red or white lead at the joints. As a rule, corrosion of the iron or copper may be expected after a time, especially in brine lines. Flanged joints should always be used in preference to screwed joints wherever practicable.

10. Aluminum joined with copper or brass. In which case corrosion of the aluminum will take place.

These instances are given to show concrete instances in which corrosion has actually taken place with resultant destruction of the positive metal. They are not merely conjectures but are actual conditions noted in practice.

In the consideration of this topic there are several conditions which are almost always present, among which are: First, a condition of strain; second, a condition of accelerated oxidation caused by the presence of oxidizing agents, such as air, and, third, a condition of accelerated corrosion caused by the effect of stray electric currents.

Strain, whether tensile, transverse or torsional, in metal always (without exception so far as is now known) sets up a difference of potential between two unlike metals joined or between a metal and its impurities. This is especially true of torsional strain.

In joining unlike metals, if there is no feasible method of avoiding such practice, great care should be taken to insure the least possible straining of the two metals. When a screwed joint is made up snug and tight there is inevitably a tremendous torsional strain set up throughout the metal and especially at the weakest portion, namely, the threads. When a flanged joint is made up no such strain occurs in the flanges, although the bolts and nuts are subjected to the same strain as in screwed joints. In fitting the flanges to the pipe ends care should be taken not to induce very great strain as here again there is the case of threads to contend with.

It seems to be excellent practice to use extra-heavy piping and fittings wherever practicable, even though the first cost is much greater. Such heavy fittings stand the strains far better than ordinary weight fittings and also make tighter joints with far less danger of leaks.

Accelerated oxidation or corrosion is often caused by the fact that piping is so set up that air accumulates at the top of fittings and in apparatus as well. Piping should be so put up that it may be vented at high points and so completely filled with the liquid which it is conveying. This is likewise true of apparatus in general. Oxidation or corrosion of this nature is always hastened if there are present combinations of dissimilar metals or metals possessing high amounts of impurities or segregation of impurities.

The action of the electric current in promoting and accelerating corrosion is so well known as to require little comment. It is well, however, to again point out that this action is always accelerated in greater degree in the case of combinations of dissimilar metals than in the case of single metals, especially in the presence of an electrolyte or moisture. In hunting down the sources of such currents it is well to bear in mind the fact that it is usually the smallest currents which in the long run cause the most damage, because they are allowed to go on in their action until at last the effect is noted in the failure of metal.

As to the proper combinations of metals in refrigerating systems there can be no fixed rule, because, as mentioned above, there are so many variable conditions present that what is good in one case may prove undesirable in another. However, there are certain combinations which seem in general to be good practice, namely:

1. Malleable-iron fittings with wrought-iron piping or nipples, as opposed to the use of cast-iron fittings.

2. Copper or brass valves or unions, etc., joined with iron but insulated by means of a heavy shellac or varnish used in making up the joints. Such means have proved successful in a number of instances, as opposed to direct contact of copper or brass with iron.

3. Cast-iron fittings and cast-iron piping.

4. Where it is necessary to join unlike metals without insulation it is good practice to use short fittings either side of the valve or second-metal fitting, i.e., in the case of a brass valve in iron pipe lines it is well to use short iron nipples or flanges at each side of the valve so that when the iron is destroyed it will be necessary to restore only these short pieces rather than whole lengths of pipe.

5. In many cases it has been noted that iron galvanized by the sherardizing process may be successfully joined with ordinary iron or even with copper and brass, whereas iron galvanized by the hot or electrolytic processes is usually destroyed under such conditions. This is probably caused by the fact that the coating on iron in the case of the sherardizing process is not pure zinc but rather an alloy of iron and zinc. At any rate it seems to be far more resistant to the action of auto-electrolysis than the usual coating of zinc.

6. Aluminum, a metal which in many solutions, including brines, actually gains in weight because of the fact that it oxidizes and retains a firmly adherent coating of the oxide, seems to have been overlooked in the design of refrigerating plants. It may be safely joined with iron, especially wrought or malleable iron, in almost every condition met with in refrigerating plants. Any action, however, which may be set up will take place at the expense of the aluminum in the case of a combination of iron and aluminum. Aluminum cannot be safely joined with copper or brass.

7. Steel pipe which has been treated in such a manner as to eliminate or at least distribute evenly the mill-scale may be joined with wrought iron or cast iron safely as a rule. It cannot be joined with copper or brass safely. The same stock without treatment for the mill-scale will

show a decided tendency to corrode when joined with wrought or cast iron. The so called "spellerized" steel fulfills this condition with respect to the scale.

There are, no doubt, many other combinations which work out well in practice under certain conditions. The above named combinations are in actual use successfully at the present time and for this reason only have they been given. The writer is of the opinion that not sufficient attention has been given to the matter of insulating joints between dissimilar metals. It seems highly probable that in the future more attention will be paid to this as it ought to solve the problem, at least partially, of combining electrically dissimilar metals in the presence of electrolytes.

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A Factor in Ice-Plant Efficiency

By Peter Neff

To anyone who has occasion to examine ice plants, there are some things which impress him immediately, and which serve as an index to the character of the manager and the engineer in charge. If the purpose of the examination, for example, is to assist in correcting some disorder affecting the capacity of the plant, information will naturally be sought from those having the plant in charge. If upon entering the plant everything is found in disorder, and the engineer dirty and slovenly, one's thoughts pass to the manager who will permit such a condition to exist, and the conviction comes that what statements they may make will have to be discounted, and it will be necessary to seek the information for one's self.

In such a plant if one asks for a piece of waste, he will usually get a dirty piece from the engineer or a rag, and in many instances there is no such thing about. No records of value are likely to be found. The manager may make a statement which the engineer will deny, perhaps not to his face but when alone with you. It is a most difficult thing to assist such a plant and it is not to be wondered at that it is not successful.

On the other hand, if everything is in order, wrenches where they belong, machinery and floor clean, engineer neat and "here take this piece of clean waste, you may need it; and if you want to go there, better put on a suit of my overalls, there is a clean set there in the locker," and when you have finished there is soap, a place to wash, and a towel; you instinctively know that the information desired will be forthcoming and in such shape as not to be contradicted; the manager will be in accord and will tell you that the engineer knows all about this or that.

The engineer of an ice plant must be far above the man who simply looks after a boiler and engine, and yet that is what some managers believe is the engineer's sole work. True, he has both of these things to do, but much more; there is the usual assortment of pumps and electric equipment; then there is the compressor, not only must he know its construction but its functions as well if he would keep it up to its maximum efficiency. The ammonia condenser to some is only a set of pipes with water over them, to the engineer it is an apparatus governed by the laws of heat transmission, and something that can do much or little depending on its condition. He will see that the ammonia leaving it is as cold as possible and will know how to accomplish this. Having made the condenser do all it can, he will see that the temperature of the ammonia is not raised after it leaves the condenser, and if the liquid receiver is placed in a hot location, he will correct this loss. Should he have a little well water and yet not enough for all purposes, he will use this for the final cooling of both the ammonia and the water to be frozen, thereby saving on the work that the compressor has to do. The ice tank will be a constant study to him, to see that the insulation is in good condition, that the circulation of the brine is the best that can be gotten, that the ice is pulled and the filling of the cans done regularly so as to avoid losses. He must know what will affect the character of the ice and see that it does not occur. He will see to it that records are kept and will check them so that he knows what goes on in the plant all the time, and can refer back to them. If he finds, for example, that for an hour or two in the night the steam pressure went down, causing the water pump to slow up and the condenser pressure to advance in consequence, and that the net results were increased fuel consumption and a decreased amount of ice made, he will be in a position to demand an explanation, and he will make no mistake in placing the responsibility.

At the end of each month he will examine his record for the corresponding month for as many years as he has had charge of the plant. If the month shows a greater production of ice, and less fuel, etc., he will feel that he is on the right track and will say that next year he will beat this year's record.

If, however, this year's record is not so good as the corresponding month the year before, he will not rest until he has found why in such plain language that anyone can understand it.

An engineer must have a desk in which to keep his papers, and the owners should recognize that this is part of the engine-room equipment. If they will not furnish one, the engineer should make one.

Nothing is so satisfactory as to know what the plant is doing, and judging this by comparing it with past records. One would suppose that all engineers would keep complete daily logs of plants in their charge if for no other purpose than to protect themselves. There is nothing more deplorable than where reports are made out without any care and perhaps thrown into a drawer and that is the end. No useful lesson is learned from them and there is no compiling for comparison with other years.

In times of trouble the true engineer is in the thick of it regardless of time, and he does not leave a plant in trouble to another. The thinking engineer today is in demand; he knows what he has done and has hopes and ideals for the future of the plant entrusted to him.

In no other industry perhaps has the engineer such direct control over the affairs of the organization he is serving, for he controls the quantity and quality of the output, and most of the expenditures connected with its production. An increased tonnage and a decrease in operating expenses makes for dividends, and the sooner ice-plant owners realize what the true engineer can do for them, the more they will seek for such a one.

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The Third International Congress of Refrigeration is only a month away. From all indications the exhibits will be unusually complete and well worth traveling over half the continent to see.

EDITORIALS

Using Office Help in Slack Time

With so much being published on efficiency, business management and standardization, it behooves the mechanical engineer, like everyone else, to study lessening the waste of time in his office. Almost every business has its slack seasons, and when the work is of a technical nature calling for some special experience, it is impracticable at such times to cut down the staff to maintain the proper balance between output and help. The great problem confronting the office manager or chief draftsman, is how to make the best use of those of his men who are temporarily idle.

One solution is to use this time for systematically collecting and classifying data relative to the business. The engineer's office offers an unlimited and absorbingly interesting field for such a system, as every branch of engineering requires special detailed knowledge. Once all the available data are collected, the process of sifting and classifying would be simple, and the result would be that in busy seasons the work of the men who did the data hunting would be vastly improved. They would have a better grasp of the technique, a knowledge of where to find the data they needed, increased interest, and greater confidence in themselves.

The office manager, on his side, would gain not only an experience of scientific methods in reference work, as well as an easy reference system for future use, but a first-class knowledge of the capabilities of his staff, especially if they had been left to do the work on their own initiative. In teaching the ropes to new men this accumulated experience filed in a card-reference system would be invaluable.

The methods of obtaining the data should be both theoretical and practical. Much valuable information could be obtained by visiting places where power plants or mechanical systems were being installed. This would give opportunity for that comparative study on the practical side which is of first importance to the draftsman when laying out work. This practical work should be supplemented by thorough scanning of current periodical and other literature in the shelves of public and technical libraries, which would show just what is being done by those highest in a particular line of work.

How many young engineers, for instance, know thoroughly the special problems connected with the ventilating, heating, and lighting of factories and workshops? A handful of men are all that have made a special study of this subject, and their writings are, as often as not, found not in the technical periodicals which the engineer has in his office, but in the proceedings of public-health bodies and reform and labor organizations. At present labor and health laws already existing in some states, and soon to come in many others, are making this subject an exceedingly live one for engineers, who in many cases, as yet, are but half prepared to handle in the best manner the special problems such legislation will create for them. This is only one among many engineering subjects in which the collection and systematization of existing data should prove invaluable to the engineer, and above all, to the young engineer with his career before him.

Data must be obtained and often at great speed, in which case it may not represent the best practice. How much better therefore to get it while there is time to spare, and not leave it to be gathered while the job is waiting to be done.

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Foaming Boilers

No doubt every boiler-house attendant some time or other has been troubled with foaming or priming boilers. That this condition is serious is only too often shown by the sudden blowing out of an engine-cylinder head, the breaking of some part of the steam line because of water-hammer, or some other mishaps usually accompanied with more or less danger.

In spite of all claims to the contrary, no boiler—except when equipped with a superheater—will deliver dry steam. This does not necessarily mean that all boilers foam, even though a small quantity of water is carried over into the steam header. It is the amount of water going into the header that differentiates between a priming and nonpriming boiler. In the former large slugs of water are thrown out and carried along in the steam line until they are either captured by a steam trap or delivered into the engine cylinder, frequently resulting in a wrecked engine.

It is also true that a steam-space of ample capacity and in a boiler that is at rest and under pressure will contain practically dry steam. But the moment this boiler begins to deliver steam and to receive heat from the furnace fires, then the water surface becomes agitated and consequently more or less water is thrown into the steam space, a part of which is bound to be picked up and carried away with the steam. While there are dry-pipes, dry-plates, dry-boxes, etc., to prevent this carrying away of the water, nevertheless some water usually will get past. This condition is not serious, however, at least from the standpoint of safety, because of the small quantity involved which can ordinarily be taken care of by proper traps. It is when the large slugs of water are carried over that the trouble begins.

For this reason every attendant of steam boilers should familiarize himself with the several causes of priming to know how to eliminate them should occasion arise.

Some of the principal reasons for a boiler priming are: rapid changes in the draft of steam or sudden demands for large volumes; defective circulation; restricted steam area; insufficient water area; forcing, or excessive evaporation; dirty water; too much soda ash in the feed water where such is used for purification; presence of oil in the boiler in connection with the use of soda ash for purifying the feed water; and presence of an excessive amount of sludge, sometimes resulting from the use of boiler compounds and graphites.

Some of these causes may be rather difficult to remove, at least without spending considerable money. On the other hand in many instances the wide-awake boiler-house attendant can determine the trouble upon proper investigation and very often apply the necessary remedy.

For example, foaming caused by sudden demands for large volumes of steam would indicate need of a larger steam-storage capacity. This might mean some steam loss from radiation, but very little with proper insulating covering. Then, again, the elimination of oil and other foreign matter from the feed water is entirely within the attendant's province and should not be too large a problem for him. As for restricted steam area, insufficient water area, etc., these cannot be remedied except by a radical change in equipment, which probably would mean laying out considerable money. It is not often, however, that a boiler of reputable make has such defects.

Usually in a boiler that tends to prime, the first remedy is to install a dry-pipe, plate or box, if the boiler is not already so equipped. It should be remembered, however, that such a remedy does not remove the cause, but only the effect, and that it is not always positive in doing this. While all boilers, as a rule, should no doubt be so equipped, yet the matter should hardly be allowed to rest there.

One-Sided Development

The failure of many a man in business is explained by the statement, "he lacks business tact and ability."

This same statement would explain the failure, or partial failure, of many a man in a professional line. The reason is that most men who acquire a high degree of knowledge of a scientific or cultural subject do not have left sufficient time and energy to develop business ability. For in these days business is almost a science by itself, and the ability to transact it is an acquired, or at least a cultivated ability by most men who have it.

The fact that men must forego cultivating this faculty while they devote their entire time and energy to cultivating a faculty along professional lines, explains the practice of so many professional people of having managers to conduct the business of marketing their services.

This arrangement among professional people has its lessons for the engineer. The competent, efficient power-plant engineer must have, today, enough "book knowledge" to entitle him to a place in professional ranks. In order to acquire this knowledge he devotes all his spare time and energy to study and experiment along the one line—engineering—to the exclusion of thought and culture along other lines, including the art of conducting business.

No wonder then that he is underpaid, which means simply that he has not, as a rule, acquired the business ability needed to sell his own services at a price which represents their real value.

But what shall he do about it? This is the practical question that arises. Engineers cannot employ business managers as do actors and musicians, or perhaps not even business brokers, as do some inventors, to market their services or product It seems certain, however, that some way could be devised to improve matters. Do engineers feel the need of doing something to improve conditions in this respect? Are they disposed to coöperate in some effort in this direction? Let us hear from men who approve the idea of making an effort, and especially from men who have any ideas about a plan.

Not all the letters that come in can be published, of course, but the first with each really new and worthy idea will be and all will be carefully considered and the composite of their ideas ultimately submitted to our readers in some form.

Engine Ratings

We find that to the layman the usual practice in rating steam engines often leads to confusion. In attempting to set our correspondents straight on this point we are often led to question whether there is any real significance to an engine rating.

If one were to attempt to settle this point by searching through engine catalogs, he would find that the majority, while specifying certain steam consumptions for full and fractional loads, nevertheless, do not commit themselves to any definite ratings for different engine sizes. This omission is undoubtedly for the purpose of permitting flexibility to suit individual conditions.

It is true that on a tentative basis most builders rate their engines at a load corresponding to about one-quarter cutoff, but this merely signifies the most economical point without reference to the maximum load the engine will carry. Moreover, engines of the same size, but of different makes, are seldom rated the same, a fact explained by the designers using different mean effective pressures.

Again, operating conditions in the average steam plant have also greatly influenced engine ratings. If the majority of plants were to operate continuously at their maximum load and the demands for exhaust steam were such as to make steam consumption a matter of secondary importance, then it might be reasonable to rate the engines at their maximum load. But as conditions actually exist, in most plants the maximum load comes on only for short periods and the engine runs for a greater part of the time at from one-half to two-thirds this maximum load; that is at a load approaching the most economical point of cutoff—if the proper-sized engine is installed.

New Jersey Engineers, Attention!

We call the attention of engineers and firemen of New Jersey to the fact that their applications for licenses must be in the hands of the Secretary of Labor, Trenton, N. J., on or before Sept. 4, to entitle them to licenses without undergoing examination. This is a privilege that all now employed as engineers and firemen should take advantage of and not lose by neglect. Firemen should realize they too must procure a license; many of them seem to think the law relates to engineers only.

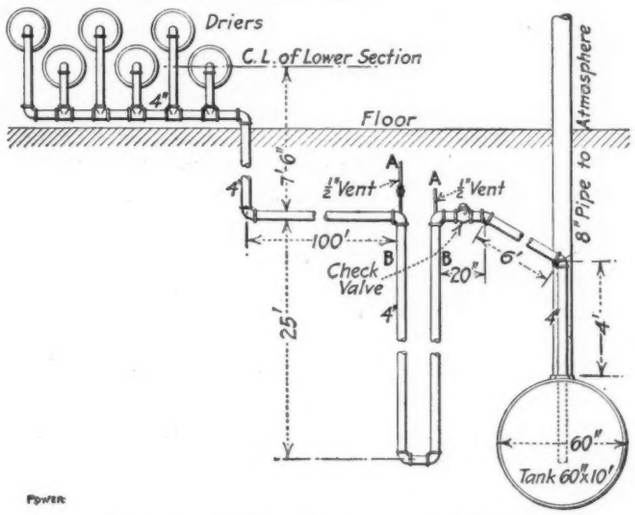
The law requires that certain information must be forwarded to the Secretary of Labor when application for license is made. On page **280** of this issue a form of application blank stating what information is needed is given. This form was prepared by A. L. Case, chairman of the License Law Committee of the N. A. S. E., for the convenience of members.

Owing to lack of funds due to failure of the legislature to make an appropriation, the bureau of examiners, the creation of which the law authorizes, will not be organized this season.

READERS WITH SOMETHING TO SAY

Air-Bound Water Seal

In a paper mill where I am employed a peculiar thing happened recently, that has remained somewhat of a puzzle ever since. There are four paper machines that discharge condensation from the driers into a receiving tank, into which also empties the condensation from the heating system. A centrifugal pump forces the water from the tank to the boiler room.



SEAL IN RETURN PIPE FROM DRYERS

When the machines were installed there was no trap, water seal or anything placed on the discharge line from the driers, consequently considerable steam passed through the driers and did not become condensed. Recently a water-seal was placed on the discharge line as shown in the sketch. One-half-inch vent pipes *AA* were placed on top of each leg *BB* of the seal. The one on the machine side had a valve while the other was at first a short piece of pipe about 10 in. long. During the first week after installing the seal, the rush of water at times was great enough to force water out at the top of this vent. This was objectionable, as employees passing below were in danger of being scalded. I therefore drove a wooden plug in this pipe, intending to have the pipe extended higher the following Sunday. This was forgotten and about 3 p.m. Monday the driers became full of water. On opening the valve on the one vent and removing the plug from the other, air issued for about ten seconds from both vents, and then a rush of hot water followed. In about five minutes the driers were empty and everything working in good order.

The line was surely air-bound, but the puzzle is how could they have become so bound? A pressure in the driers of 5 to 10 lb. and a head of 7½ ft. from the driers to the top of the seal would surely be sufficient to force air into the tank, in which no pressure above the atmosphere could exist. It seems impossible that air could gather and remain in the top of the seal next to the tank sufficiently to choke the water back, for it would be necessary to confine it on all sides, and next to the tank there is no pressure to do this. It seems possible that air enough might gather in the machine side of the loop to reduce the flow of water, as it (the body of air) would be subjected to pressure on all sides. But if that is true, why does it not occur again as the valve in the vent pipe is closed all the time. The one on the other side is open all the time, but how could it affect the other side of the seal? There must have been some water passing into the tank, else the driers would sooner have become filled. The tank is provided with an overflow and was in good condition at the time, so it was not filled with water above normal.

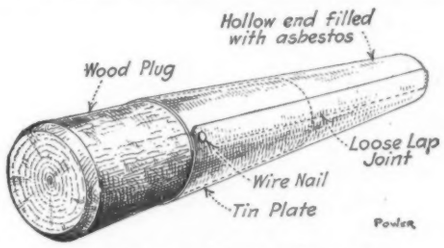
If air on the tank side restricted the flow of water, how is it to be accounted for? If it was air on the machine side that did it why does it not happen again? If the check valve was stuck, or failed to lift enough, why would opening the vent pipes remedy it? The writer will be pleased to have this explained.

JOSEPH STEWART.

Hamilton, Ohio.

Plugs for Hollow Stays on Heine Boilers

Some time ago the writer was associated with the operation of a power plant where Heine boilers were installed. As those familiar with this type of boiler are aware, the front and rear headers have openings let through them for the purpose of blowing off the tubes, these openings being in the form of hollow stays which are beaded over at each end. At first, when the number of boilers was small, tapered wooden plugs were used to



PLUG FOR HEINE BOILER

close these openings as it was found that through the expansion and contraction almost any type of metal plug would soon loosen and fall out of place.

The wooden plugs were far from satisfactory because their inner ends, being exposed to the heat of the furnace, would burn off, necessitating renewal of the plugs after about ten days' use. With only a few boilers in use this was not a serious consideration, but as the plant grew and more boilers were added, it became necessary to employ a large proportion of a man's time turning new plugs.

After various expedients had been tried and discarded, the writer suggested a form of plug, which was experi-

mented with and found satisfactory. This was a taper plug made in the manner shown in the sketch. To construct a sample for trial, one of the old plugs was turned down in a lathe an amount equal to the thickness of a sheet of tin. The small end was cut off about 1½ in. back and had tin plate wrapped around the stub, overlapped and nailed. The small end of the tin plate being free at the joint will spring open and shut, the tin sliding over itself at the lap. Then the opening formed by the extension of the tin beyond the wood was filled with asbestos to protect the wood stub, and rammed tight, the reduced size of the chamber at the open end holding the asbestos in place. When these plugs are tightly inserted in the holes the free ends of the tin tubes are slightly compressed and the spring of the tin plate takes up all difference of expansion.

These plugs cost about three times as much as the plain wooden ones, but some that were examined after six months' use appeared to be as good as new, with prospects of lasting indefinitely.

OTTO E. TRAUTMANN.

New York City.

Had No Success with Graphite

The Esterville (Iowa) Light, Power & Water Co.'s plant of which I have charge has horizontal tubular boilers. Each gallon of feed water contains: 27 gr. sulphate of lime, 5 gr. carbonate of lime, 12 gr. carbonate magnesium, 2 gr. sodium ~~potassium~~ sulphate, 1 gr. sodium potassium chlorides.

Many different boiler compounds have been used, also kerosene in large quantities, but these boilers have been heavily scaled since their installation.

About two years ago I began feeding caustic soda and soda ash and in six months the boilers were free from scale. The fire sheets threw off the scale much more rapidly than the flues. Of course, we were troubled from foaming, packing troubles and lubrication troubles due to the action of the caustic soda, but we always managed to work the boilers to full capacity and considerable overload. Wishing to overcome these last-named troubles I decided to try graphite.

We got a 100-lb. keg of boiler graphite of a well known make, read the directions and started using it by doubling the dose recommended. The fire sheets were absolutely clean and the flues were practically free from scale when we began using the graphite.

Two weeks after using the graphite I washed the boilers and found a coating of hard, white scale about the thickness of an egg shell over the fire sheets. We continued the use of graphite until 100 lb. were used and then started on another 100-lb. keg of graphite.

Each two weeks' run showed a corresponding increase in the thickness of the hard, white scale until the second keg of graphite was used. The flues seemed to hold their own, neither throwing off any old scale or accumulating any new. But the fire sheets had rapidly taken on new scale. What better test could be given the graphite than these clean sheets to start on?

We went back to caustic-soda treatment and the new scale was all off again in about two months. I wrote the makers of the graphite, giving them the same explanation that I have given here, and in their reply they simply said that if I used the graphite according to their instructions there was not a case of boiler scale that would not yield to the graphite treatment. I was very anxious to make it a success as it would have been a boon to our steam plant had it been a success.

The first boiler inspector's report in 18 years to read "boilers free from scale" came to this plant recently because of the use of caustic soda and soda ash. We use 1 lb. soda ash and ⅛ lb. caustic soda to 600 gal. feed water.

E. C. SUTTON.

Esterville, Iowa.

[The manufacturers of boiler graphite up to the present, have not made broadly the claim that graphite would prevent the formation of scale. The product is recommended chiefly as a scale remover. It is probable that if Mr. Sutton had emptied his boilers and coated the shell with graphite while the plates were free from scale, no scale would have formed. Some engineers coat the boiler with graphite and also use soda ash.—EDITOR.]

Iron in Receiver Goes to Engine

In this plant one of our 60-hp. cross-compound Corliss engines suddenly developed a loud knock. On shuting down the engine, we found that the piston rod on the low-pressure side was bent. The piston head was taken off and all the follower bolts were found in place. The valves were taken out and found in good condition. The piston was then removed. On the crank-end cylinder head and on the spider were found impressions like the picture of a bird with its wing outspread. A piece of iron in this shape was found, which had dropped through the valve into the exhaust chamber.

Next the receiver was opened and a bucketful of iron clamps and pieces of packing rings was taken from the bottom. The clamps had fallen off the heating coils.

One of the these clamps was picked up by the steam and blown through the low-pressure cylinder, being caught between the piston and head, and the clamp then fell through the lower valve. Strange to say, it passed through both the valves without injuring them.

T. F. WHITE.

Handley, Tex.

Test for Pressure Drop in Long Steam Pipe

A test for pressure and temperature drop on a 5-in. steam line 1700 ft. long, having thirteen 90-deg. elbows and covered with the best grade of pipe covering, showed a pressure of 155 lb. at the boilers, with a steam temperature of 470 deg., 102 deg. superheat. At the end of the line a pressure of 150 lb. was obtained, with a temperature of 365 deg. and practically dry steam.

This line supplies steam for operating a 50-ton ice machine, a three-cylinder compound pumping engine, 13, 16, 13⅞ and 18 in.; one 7½- and 4½x10-in. pilot-pressure pump and eight vacuum pumps of various sizes. Steam is supplied to this line by a 500-hp. water-tube boiler.

During the 24-hr. test, while the steam was carried at 155 lb., the superheat ranged from 89 to 102 deg., according to the load on the boilers.

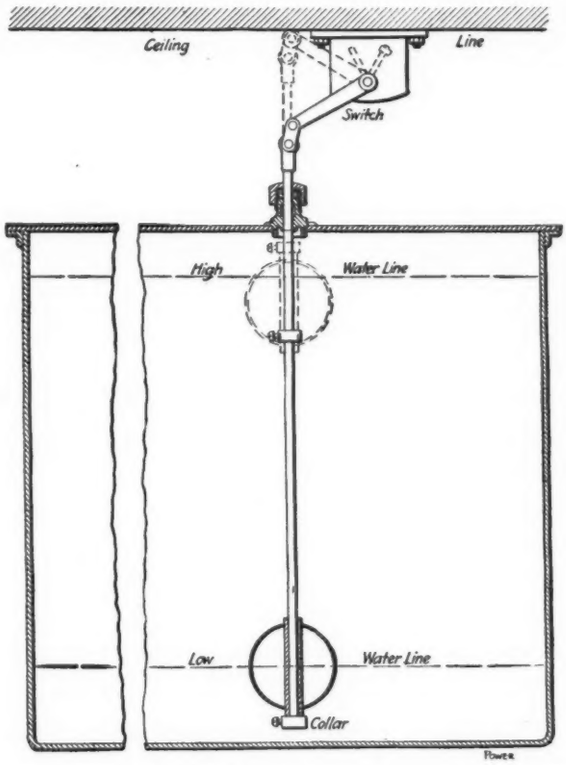
F. J. RAVLIN.

Chicago, Ill.

QUESTIONS BEFORE THE HOUSE

Float Switch for Tank with Little Headroom

The automatic pump control shown by H. B. McDermid in the July 1 issue brings to my mind an automatic pump control which I made and installed on a tank of heavy boiler iron measuring 24x48x72 in., and which served as a receiver or drip tank, to which all the trap discharges in various parts of the factory were returned,



HOME-MADE TANK SWITCH

being then pumped from this tank by an electrically driven triplex pump to the main storage tank for hot water located in the heater room.

As this tank was placed in the basement of the boiler room the height of which was about 6½ ft. from the ceiling to the floor, there was very little head room between the tank and ceiling. It was desired to have the pump draw the water to within 6 in. from the bottom, also to allow the tank to nearly fill before starting the pump.

The available headroom between the top of the tank and the ceiling was about 18 in. and as it was desired to have the tank steam tight, the chain and float with counterweight could not be used as steam would leak around the chain where it passes through the top of the tank. It was decided that a rod could not be used because it would have to have a movement of nearly 40 in.

Taking a heavy 8 in. copper float I drilled a hole through its axis large enough to fit a ½-in. pipe. This pipe was cut off within ¼ in. of each end of the float and soldered water tight. With a suitable stuffing-box obtained from an old globe valve and with a rod of proper size and length, I placed the float on the rod and adjusted the collars to the height of water I wished to carry. The tank switch, which is of the spring-trip quick-release single-pole type, is mounted on the ceiling directly above the tank, and the rod, with suitable link connection as shown in the sketch, was connected to the operating lever of the switch. This switch merely opens and closes the motor circuit by opening and closing the circuit breaker. The pump is a triplex, single-acting pump of 120 gal. per min. capacity and pumps the tank dry in five to six minutes. This outfit is looked after about once a week and has given no trouble since it was put in about 3 months ago.

Comment on Peculiar Diagrams

Replying to John T. Sharp, Jr., in the June 17 issue, as to the unusual indicator diagrams, I wish to say that the engine from which these diagrams were taken is evidently running light, as the cutoff should be 25 per cent. for good working loads. The lower diagram is all right for the load, the other shows too early compression, too late and too slow release. I think if these were remedied, the cutoff would take care of itself. When the latter two conditions are fixed, there should be no loop and there would be a horizontal exhaust line.

S. T. BLAKEMAN.

Senatobia, Miss.

Air-Driven Pump Freezes

In reply to the question of H. E. Leonard on page 138, July 22 issue, I operated an air-driven pump in a coal mine using air at 70 lb. pressure. The pump was 1000 ft. from the compressor, and I experienced the same trouble he speaks of. During the warm weather ice would form on the end of the exhaust pipe that I would knock off with a hammer, but in cold weather ice would form under the slide valve and would obstruct the exhaust. When the pump commenced to slow down I would stop it and let it stand about five minutes. That would let the temperature rise; then when I started it again the ice would break loose from the valve and blow out. This operation was repeated whenever it was required.

The proper way to remedy this trouble is to put a ⅛-in. pipe inside the exhaust pipe and bring it out through the exhaust pipe and connect it to the discharge pipe of the pump. The ends of the ⅛-in. pipe should be flattened a little so as to make a spray.

F. M. BENJAMIN.

St. Cloud, Fla.

[More good discussion of means to prevent the freezing of air-driven pumps would be welcomed.—EDITOR.]

INQUIRIES OF GENERAL INTEREST

Electrical Capacity Measurement—In what units is the capacity of an electrical condenser measured?

B. M.

The unit of capacity is the farad, which is defined as the capacity of a condenser which requires one ampere per second to raise its potential from zero to 1 volt.

Safe Boiler Pressure—What steam pressure is allowable on a water-tube boiler and what on a fire-tube boiler?

J. C. M.

The pressure allowable for any boiler depends on its design, material of construction, workmanship and condition. Water-tube boilers are generally made to carry 150 to 200 lb., while present fire-tube boilers are generally made to carry 100 to 150 lb. However, the pressure allowable for a boiler of either class depends, in any case, on the pressure assumed to be safe after inspection, computation of strength and application of a hydraulic test pressure.

Belt Splice—How should a cemented belt joint be lapped and which direction should the belt run?

E. H. B.

A belt with a cemented lap joint should be driven in such a direction that the lap next to the pulley will be wiped down by the pulley on which the belt is more likely to slip. Therefore, if the driving pulley is larger, or of the same diameter as the driven pulley, then, as slipping is more likely

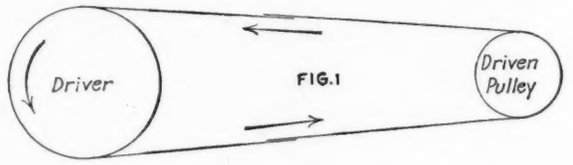


FIG.1

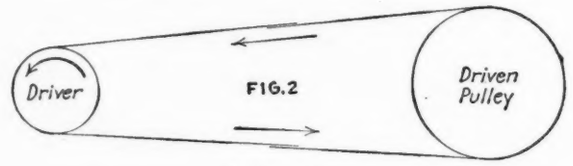


FIG.2

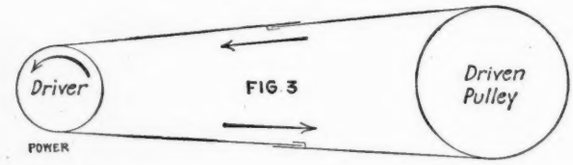


FIG 3

to occur by the belt being dragged over the driven pulley, the butt end of the flap should travel forward, as shown in Fig. 1. If the driving pulley is smaller than the driven pulley, then slipping being more likely to occur by the driving pulley slipping ahead of the belt, the belt should be put on so the thin end of the flap travels forward, as indicated in Fig. 2. A graft lap, like Fig. 3, should be used when conditions require the main lap to travel in the direction shown in Fig. 2, but no graft lap is necessary when conditions require the main lap to travel as shown in Fig. 1.

Pipe-Fitting Friction—In its resistance to steam flow, how would the friction in a 90-deg., 7-in. elbow compare with that in straight pipe?

W. W. C.

It would be equivalent to the resistance in passing through about 520 diameters of pipe of the same size, i.e., a 90-deg. elbow in a 7-in. steam line offers the same resistance to flow as passage through

$$\frac{520 \times 7}{12} = 303\tfrac{1}{3} \text{ ft. of 7-in. pipe.}$$

Engine Economy—We have a noncondensing Corliss engine supplied with steam at 80-lb. pressure and cutting off at 1/5-stroke. About how much could be saved by installing a new boiler and carry 100 lb.?

J. N.

With 80-lb. boiler pressure and cutoff at 1/5-stroke, the terminal pressure would be down very close to atmospheric pressure. At 100-lb. initial pressure, cutoff, with the same load, would be so short as to cause expansion below the atmosphere, thereby causing cylinder cooling by drawing in air during the first part of the return stroke. Under such circumstances 100-lb. initial pressure would not be as economical as the present 80-lb. If a diagram taken with average load shows no more than about 3-lb. terminal pressure, then it certainly would not be more economical to install a new boiler and use 100-lb. initial pressure.

Mean Effective Pressure—How is the mean effective pressure found without an indicator?

C. E. M.

It can be estimated from knowledge of the initial pressure, point of cutoff and average back pressure by the formula

$$P_m = (1 + \log_e R)\ (f + c) - c,$$

in which

P_m = Mean forward pressure per pound of initial pressure;
$\log_e R$ = Logarithm of the ratio of expansion;
f = Per cent. of cutoff;
c = Per cent. of clearance.

From this mean forward pressure the mean back pressure (both absolute) is subtracted, leaving the mean effective pressure. Instead of making the computation, the mean forward pressure is usually taken from tables such as those in Low's "Steam Engine Indicator," pages 115 and 116.

Connecting Waterwheel and Engine—Is it advisable to connect a waterwheel having no governor and an engine so as to obtain their combined power on a single shaft? How should it be done?

I. C.

It would be feasible to connect the engine with the waterwheel, with a governor only on the engine, if the power is always in excess of the amount developed by the waterwheel and the engine and waterwheel are coupled together so that each runs at its proper speed. Care should be taken that the engine is started first, or that it is thoroughly warmed up before the waterwheel is started, as a head might be knocked out if there was water in the cylinder of the engine. It is safest to have a clutch coupling between the powers and after starting the waterwheel slowly to start the engine slowly with the drip cocks open and bring the speed up gradually on both the engine and the waterwheel before throwing in the clutch coupling.

Corliss and Slide-Valve Engine Cutoffs—Why is it that a Corliss valve gear with one wristplate cannot cutoff between near one-half stroke and a point very near the end of the stroke? Why, with a plain slide valve, is it impracticable to cutoff before one-half stroke?

E. H. I.

A Corliss valve gear with one wristplate has to open and close the exhaust valves of the engine by a reciprocating motion during one-half of a revolution of the engine; i.e., during the return stroke of the piston, as the exhaust-valve connections with the wristplate are positive in their action. The cam-cutoff mechanism of the steam valves is operative in only one direction and, as the wristplate for operating the exhaust valves has to be reversed when one-half of the stroke is completed, the cutoff cams cannot control cutoff through a greater range than one-half stroke.

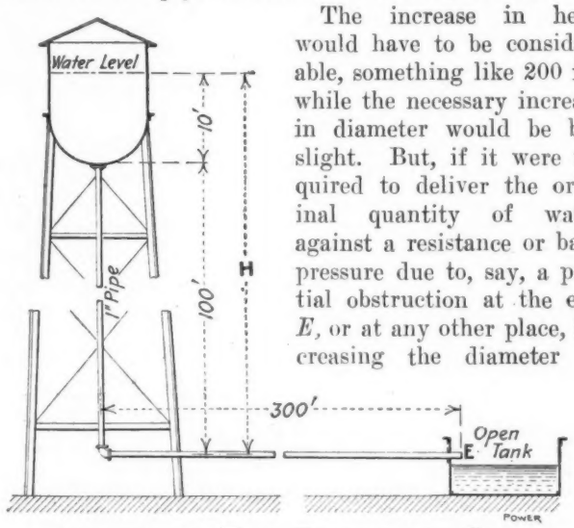
To effect cutoff with an ordinary slide-valve engine it is necessary to advance the eccentric, thereby simultaneously advancing the time of admission, release and closing of the exhaust. By adding lap to the steam ends of the valve, undue lead can be prevented, and early opening of the exhaust also can be prevented by adding inside lap (i.e., on the exhaust edges of the valve). But if these operations are carried so far as to be adapted to cutoff at less than about five-eighths stroke, early release and back pressure are increased so much as to reduce power and economy below practical requirements.

ENGINEERS' STUDY COURSE

Chimney Design

When water is conveyed in a pipe the quantity delivered per unit of time depends upon the diameter and length of the pipe, the friction due to the nature of the pipe surface and the kind and number of the turns in the pipe, the difference between the pressure or head at the starting point and at the delivery point.

For illustration, consider a 1-in. pipe line, 400 ft. long, arranged as shown in Fig. 1. Assume that under the conditions shown, 9 gal. of water is delivered per minute and that it is desired to increase the quantity to, say, 12 gal. per min. As the nature of the pipe surface and the number of turns cannot be changed, it will be necessary to increase the head H or increase the diameter of the pipe to secure the desired result.



ILLUSTRATING HEAD FRICTION AND FLOW

The increase in head would have to be considerable, something like 200 ft., while the necessary increase in diameter would be but slight. But, if it were required to deliver the original quantity of water against a resistance or back pressure due to, say, a partial obstruction at the end E, or at any other place, increasing the diameter of the pipe would be of but slight use. The only benefit derived would be a certain reduction in the friction of the pipe itself, which would leave just that much more pressure available at E for overcoming the resistance there, resulting in a somewhat increased flow.

On the other hand, any increase in head H, produced by raising the upper tank, would almost all be available for overcoming the local resistance or back pressure at E, the only amount lost being due to the slight additional friction of the required additional length of vertical pipe.

The principles of boiler-furnace draft, produced by a chimney, are very similar to those involved in the foregoing illustration. One difference in actual application is that the chimney system seemingly works upside down. The boiler room itself corresponds to the overhead tank in Fig. 1; the furnace, gas passages of the boiler, breeching and chimney are the piping system. But, instead of the flow being downward, as in the case of the water system, it is upward. Nevertheless, gravity is the actuating force in both cases. The heavy cool air outside the chimney containing the light, hot gases has, due to the force of gravity, a continual tendency to seek its own levels in the chimney and force up the light gases. It never succeeds, however, for as long as the fire is maintained the heavy cool air is converted into light hot gas in passing through the fuel bed.

The important point of comparison between the water system here illustrated and a natural-draft system is that similar changes in dimensions or design produce similar results. If it is desired to increase the head (or draft) so that a certain rate of flow may be maintained against a given resistance, logically, the height of the water pipe or chimney, as the case may be, must be increased. While increasing the area of the piping or the gas passages helps to a slight extent, the main resistance (at E, Fig. 1, or at the fuel bed in the case of a draft problem) is usually so large that only a change in height will suffice. In other words, the head or draft, or tendency to flow—whichever you call it—must be great enough so that the resistance or friction will be overcome and there will still remain a certain amount of draft to produce a flow or velocity sufficient to handle the required quantity of gas per unit of time.

When this condition has been fulfilled the size of breeching and diameter of chimney must be determined. Here, just as with the water piping, the area of the passages is the factor which has the greatest effect on the capacity (volume of gas handled per unit of time). And it is poor economy to add to the height simply to increase the capacity by making the velocity abnormally high.

ESTIMATING DRAFT REQUIRED

Before we are in a position to design a suitable chimney for a given plant we must have some data as to the draft that will be required under the working conditions. Knowing this, we can then determine the necessary height. To estimate the draft that will be required we must know the approximate nature of the fuel to be burned, the rate at which the fuel is to be burned, the grate area, the type of boiler to be used, manner of baffling, length of the breeching, its cross-sectional area and the number of turns it makes. In fact, we should know, if possible, all the factors that affect the draft and the amount of their influence.

Unfortunately, it is almost impossible to permanently determine all the factors. After a plant has been running a year or so, it may be necessary to change the grade of coal used. Or, it may be necessary to add more boilers than were originally provided for or to greatly overload the existing plant. All these changes would have their effect on the draft requirements. Hence, as the load on the stack is usually increased and but seldom diminished, it is a good and safe mistake to make the chimney too large rather than too small. The intelligent engineer will offset too much stack capacity by a careful use of the dampers, but he is helpless if he is afflicted with a heavily overloaded chimney.

The study of draft losses in a boiler installation is such a broad one and so many factors enter into the

problems involved that it is impossible to do more than briefly outline the details here.

In calculating the draft required for a given installation allow 0.001 in. of water for each foot in the length of the breeching, measured from the chimney to the nearest boiler; 0.05 in. for each right-angle turn in the breeching, and 0.4 in. for the boiler or boilers themselves.

These figures are based on average conditions and they are safe for use with most of the ordinary installations where the cross-sectional area of the breeching is 20 per cent. greater than the smallest free cross-sectional area of the chimney and where the boiler is of any standard design and has the usual baffle and gas-passage arrangements.

After having allowed a certain quantity of draft for overcoming the resistance of the boilers and gas passages it is next necessary to estimate the draft required at the fuel bed. This factor depends on the kind and size of the fuel to be burned and the rate of combustion required to carry the load on the boiler.

To estimate the rate of combustion it is necessary to take into consideration the maximum horsepower to be developed; the pounds of coal required to develop one horsepower-hour, and the area of the grate. Multiplying the first two factors together and dividing by the last gives the rate of combustion in pounds per square foot of grate per hour. When this quantity has been estimated the approximate draft required may be obtained from Table 1, compiled from some data given in "Stirling" and some furnished by the Green Engineering Co.

TABLE I. DRAFT REQUIRED IN INCHES OF WATER FOR VARIOUS COALS AND RATES OF COMBUSTION

Kind of Coal	Pounds of Coal Burned per Sq.Ft. of Grate per Hr.								
	10	15	20	25	30	35	40	45	50
Run-of-mine—bituminous	0.07	0.12	0.18	0.23	0.30	0.37	0.45	0.52	0.60
Bituminous slack	0.09	0.14	0.23	0.30	0.40	0.48	0.57	0.65	0.75
Run-of-mine—semi-bituminous	0.07	0.14	0.23	0.32	0.45	0.60	0.77	0.95	1.20
Semi-bituminous slack	0.10	0.16	0.28	0.40	0.57	0.73	0.90	1.10	1.37
Anthracite pea	0.16	0.30	0.45	0.64	0.88	1.25			
Anthracite No. 1 buckwheat	0.23	0.43	0.68	1.00	1.40				
Anthracite No. 3 buckwheat	0.39	0.75	1.25	2.00					

To illustrate, assume that it is desired to find the draft required by an installation of four 400-hp. boilers, the maximum load on which is to be 2000 hp.; the fuel is to be a fair grade of semi-bituminous mine run, 3½ lb. of which are sufficient to develop one boiler horsepower under fair, average conditions; the area of the grate under each boiler is 88 sq.ft. The breeching is 30 ft. long and has one right-angle turn.

The draft loss for the breeching will be

$$(30 \times 0.001) + 0.05 = 0.08 \textit{ in. of water}$$

and assuming 0.4 in. for the boilers themselves, the total draft loss from furnace to stack will be

$$0.4 + 0.08 = 0.48 \textit{ in.}$$

As 2000 hp. are to be developed requiring the combustion of 3½ lb. of coal per boiler horsepower per hour, the total coal to be burned per hour equals

$$2000 \times 3.5 = 7000 \textit{ lb.}$$

As the total grate area is

$$4 \times 88 = 352 \textit{ sq.ft.,}$$

the pounds of coal burned per square foot of grate per hour will be

$$\frac{7000}{352} = 19.9$$

By referring to Table 1 it will be found that 0.23 in. of draft is required for the combustion of run-of-mine semi-bituminous coal at a rate of approximately 20 lb. per sq.ft. of grate per hour. Then, adding this quantity to the quantity estimated to be required to overcome the resistance of the boiler and breeching, we have a total draft requirement of

$$0.48+0.23=0.71 \textit{ in. of water.}$$

The next step is to estimate the height of chimney required to develop this amount or intensity of draft.

Height of Chimney

In a previous lecture a formula was given for estimating the amount of draft to be expected of a chimney of a given height under certain conditions. By rearranging and modifying this formula slightly it will serve for estimating the height of chimney required when the draft is known. The original form (see issue of Aug. 12) was

$$D = 0.52\ H \times P\left(\frac{1}{T}-\frac{1}{T'}\right)$$

By transposing the factor H to the left side of the equation the formula takes a more convenient form for its present application, thus,

$$H = \frac{D}{0.52\ P\left(\frac{1}{T}-\frac{1}{T'}\right)}$$

where D represents the draft required and all the other symbols are the same as in the previous case.

Now, the chimney itself offers some resistance to the flow of the gases and allowance should be made for this. A common estimate of this loss is 20 per cent. of the total draft developed. That is, if a perfectly frictionless imaginary chimney could develop, say, 1.25 in. of draft, in actual practice a chimney of the same size would develop only 80 per cent. of this figure, or 1 in., the other 20 per cent. being lost in overcoming the friction that every actual chimney possesses.

Hence, in applying the foregoing formula we should first increase by 25 per cent. the figure representing the draft required, so as to obtain a chimney of such height that 20 per cent. of the estimated draft may be lost and still leave the required amount. Or, better still, we can change the formula to take care of this by multiplying the draft required by the factor 1.25, making the formula read thus:

$$H = \frac{1.25\ D}{0.52\ P\left(\frac{1}{T}-\frac{1}{T'}\right)}$$

In applying this formula to the draft problem just illustrated, we must first ascertain what the average atmospheric pressure (P) is at the location of the plant. At or near sea level, this pressure may be taken as 14.7 lb. per sq.in., but where the altitude is considerable, as, for instance, at Denver, which is at an elevation of over 5,000 ft. above the sea, a closer figure should be taken. At Denver, 12.5 lb. per sq.in. would be proper.

We must also ascertain what the average atmospheric temperature is at the place where the plant is located and estimate what the temperature of the flue gases probably will be. The last-mentioned factor will depend upon the design of the boiler, arrangement of baffles, cleanliness of the heat-absorbing surfaces, rate of combustion, and, somewhat, upon the efficiency of combustion. On an average the flue-gas temperature ranges between 450 and 600 deg.

In our present example, assume that the atmospheric pressure is 14.7 lb. per sq.in., the atmospheric temperature is 70 deg. F., and the temperature of the flue gases 500 deg. F. The corresponding absolute temperatures are 530 and 960 deg., respectively.

Substituting in the formula, then, we find the height of chimney required to develop an available draft of 0.71 in. is

$$a = \frac{1.25 \times 0.71}{0.52 \times 14.7\left(\frac{1}{530} - \frac{1}{960}\right)} = \frac{0.8875}{7.644\left(\frac{430}{508{,}800}\right)} = 137.38 \text{ ft.}$$

or, in round numbers, 140 ft. above the grates.

Diameter of Chimney

Having determined the proper height of chimney for a given set of conditions it is next necessary to estimate the required free cross-sectional area. For this the following formula may be used:

$$E = \frac{F}{16.65\ \sqrt{H}}$$

where

E = Cross-sectional area of the chimney in square feet;
F = Pounds of fuel to be burned per hour;
H = Height of chimney above the grates in feet.

Applying this formula to our example, we have

$$E = \frac{7000}{16.65\ \sqrt{140}} = \frac{7000}{16.65 \times 11.83} = 35.5 \text{ sq.ft.}$$

The diameter of a chimney of this area would be about 6 ft. 9 in.

Chimneys are usually built circular because this form is cheaper, more stable and more efficient than any other. It is cheaper because less material is required for a chimney of a given cross-sectional area; more stable because the curved surface of a round chimney offers less resistance to the wind than the flat surface of a square or other polygonal (many-sided) chimney; also, because structurally the circular section is stronger. A circular chimney is more efficient because the resistance to the flow of the gases is less per unit of sectional area and the amount of exposed surface is less than with any other shape due to the fact that the circumference of a circle is shorter than the perimeter of a square or polygon.

Practice Problem

By way of exercise, those who are interested may work out the dimensions of a chimney for the following conditions: Eight 500-hp. boilers, with grates 83 sq.ft. in area, to be fired with bituminous slack, the combustion of 4 lb. of which is required per boiler horsepower-hour. At times the boilers will be overloaded 25 per cent. The breeching is 50 ft. long from the chimney to the nearest boiler and has two right-angle turns in it. The plant is located about 2000 ft. above sea level, where the average atmospheric pressure is 13.57 lb. per sq. in. The temperature of the outside air will average 60 deg. F. and that of the flue gases 550.

⁂

Superheaters are to be applied to all the locomotives on the New York, New Haven & Hartford R.R. The estimated expenditure is nearly $1,000,000, and the locomotives will be equipped at the rate of five per month. The work will be done at the Readville, Mass., shop, and about 350 locomotives in all will be altered.

OVER THE SPILLWAY

JUST JESTS, JABS, JOSHES AND JUMBLES

Concluding that a hermetically sealed package contained a liquid explosive, a weisenheimer put the package in a pail of water. We'd like to know just what action water has on a hermetically sealed package.

⁂

Editor the Spillway:

In a recent issue there's an article, "Heating Engineers Meet at Buffalo." This makes me hot. Why single out Buffalo engineers when they are heating engineers' meat in every city in the U. S.?

Chicago, Ill. R. C. SMITH.

Look'y here, Mister Smith, you're trying to kid us. It's all very well to heat the meat if you don't have to meet the heat—of a Chicago summer. Anyhow, buffalo meat is a luxury these high-living days, and once a year is none too often.

⁂

Secretary Daniels of the Navy would give every enlisted sailor a chance to learn a trade; "make Jack a useful citizen when he retires." The same thing is advised for Tommy in the Army. When Henry, in the power plant retires— Oh, well, we had a suggestion for Henry, but he dont retire so's you can notice it; he has to keep on going.

⁂

The new steamer "Tyler," remarks the "New York Times," has "one triple-expansion engine, with cylinders 19¾, 33¼, 58 in. diameter by 42-ft. stroke." Some stroke!

⁂

A Western farmer has an artesian well from which he gets sufficient power to electrically light his house and barns and operate some small machinery. In most of those wells we call artesian in the East the water has to be coaxed up to the surface, and the internal force wouldn't light a match.

⁂

Ever smoke an Igorot cigar? Well, these Igorots, in the Philippine Islands, make a cigar that in one respect is like the old-time Christmas plum pudding—it lasts a week. It's 15 in. long and 3 to 5 in. thick. Old man Ig. rolls the cig. and smokes it an hour; then Missis Ig. and all the little Igs. take their turns. By about the fourth day it must need a cuspidor attachment to keep it in operation. One smoke like this would last some people a lifetime.

⁂

COME WITH US, ALEXANDER!

Are you going to the Springfield N. A. S. E. convention on Sept. 8? This question should be agitating your mind, Alec, this present moment.

If you can't go, that lets you out right here and now. If you are just doggone indifferent or haven't made up your mind either way, you listen to your Uncle Bill!

You've probably stuck around the plant 335 days this year; you've gone stale, and peeved, and grouchy. The kids get on your nerves when you come home nights; the insurance premiums are pestering you; your grocer is sure cheating you out of your eye-teeth; the butcher is buying a new buz wagon on your monev—mebbe the washlady has a new bicycle because she put a few over on you, or—

Say, Alec, you go easy with the whip, this is a hired rig. All you need is a rest-up and a ride in the cars to Springfield. Come across with yourself. When, at the supper table tonight, you've finished your second helping of corned beef and cabbage, you up and tell your Ethel—

"Old girl, you corral a few of your best duds, lay out my funeral pants, my Sunday shirt and those blue silk socks, dig up a couple of suitcases. You and I are going to the convention! N-e-v-e-r m-i-n-d, now! Aunt Hannah will come over and mind the kids. You-and-I-are-going-to-Springfield. Get me, Ethel?"

Then, for the loveofmike, stick! If you can't see your way to stop at the Walledoff-Castoria, go stop with grandma Spriggins—or even with Ethel's mother. But go!

Honest, Alec, you can't count in dollars and cents the good it will do you—and Ethel. Aunt Hannah may not be any too tickled, but the kids will be glad to get rid of you. And they'll love you all the more on your return with a sunny smile instead of the old grouch.

Come with us, old man. It's all aboard for Springfield, and everybody's doing it. You do it—now!

Application for New Jersey License

The time in which the engineers and firemen of New Jersey have to make application for a license without being examined is growing very short, for to enjoy this privilege, one's application must be in the hands of the Secretary of Labor, Trenton, N. J., on or before Sept. 4.

The accompanying application blank shows the information which the law states must be forwarded to the Secretary of Labor when making application for license.

The form was drawn up and prepared by A. L. Case, chairman of the New Jersey License Law Committee of

FORM D-1-13

STATE OF NEW JERSEY **APPLICATION NO.** DEPARTMENT OF LABOR

BUREAU OF ENGINEERS AND BOILER OPPERATORS LICENSE

APPLICATION FOR ..... LICENSE

..... N. J. 191

Name .....

Post Office { Street and Number ..... / City or Town ..... County .....

Age ..... Color ..... Nationality ..... Citizen .....

Experience as Stationary Engineer ..... Years ..... Months

Experience as Locomotive Engineer ..... Years ..... Months

Experience as Portable Engineer ..... Years ..... Months

Experience as Hoisting Engineer ..... Years ..... Months

Experience as Marine Engineer ..... Years ..... Months

Experience as Oiler in Engine Room ..... Years ..... Months

Experience as Boiler Operator ..... Years ..... Months

Experience as Locomotive Fireman ..... Years ..... Months

Experience with Steam Heating Plants ..... Years ..... Months

What kind of a boiler, or boilers have you in charge of at the present time? .....

What is the Horse Power? .....

Do you supply water to your boiler with a pump or injector? .....

What kind of engines are you now running? .....

What is the Horse Power? .....

Do you operate electrical Machinery? .....

If so, for what purpose? .....

If you use steam for heating purposes, by what system? .....

Do you use condensers? ..... If so what type? .....

Is firing done by hand, or with stokers? .....

Do you have mechanical ventilation? ..... System .....

Do you operate elevators? ..... Name of Manufacturer .....

Do you operate refrigeration? ..... For what purpose .....

By what system? ..... Absorption or direct expansion? .....

What is the name and address of firm by whom you are now employed? .....

For what is the plant used that you desire to operate? .....

Have you ever applied to any District Examiner in New Jersey for an examination? .....

If so, did you secure a license? .....

Who was the District Examiner? .....

What was the date of your LAST examination? .....

Do you now hold a license? ..... If so give No. .....

When does your license expire? .....

Applicant's Signature .....

The applicant whose signature appears above is employed as engineer at .....

and who request that a proper license be issued to him

Signed .....

Title .....

Address .....

the N. A. S. E., and was distributed by him to N. A. S. E. associations for the convenience of the members. Bear in mind that if your application for an engineer's or fireman's license is not received by the Secretary of Labor by Sept. 4 you must stand examination. Space at the bottom of the blank is provided for the signature of employers as required by the law.

Melms and Pfenniger are making a 2500-kw. turbine, which they guarantee to run on 11 lb. of steam per kw.-hr. with an initial pressure of 14 atmospheres, 250 deg. F. superheat and 28 in. vacuum. The blading section is only about three feet long and consists of two velocity stages (Curtis) and a number of Zoelly pressure stages. It is single flow with a single dummy piston of sufficient diameter to balance the entire end thrust.

A Comparison of Piston-Rod Packing

By W. E. Sanders

SYNOPSIS—A brief description of various kinds of piston-rod packings, and their adaptability for the service. A comparison is made regarding the cost and wearing qualities of the several kinds.

Every engineer or superintendent is vitally interested in minimizing the power-plant operating expenses. This is his chief problem and one that is never solved satisfactorily because there are always opportunities arising for producing economy that have been overlooked.

When it comes to supplies that are used up and renewed, such as coal, water softeners, oil, grease, packing, etc., the problem becomes complex and admits of no very exact or definite answer. The packing problem is such that it is impossible to obtain a solution that will be applicable to every installation, since the conditions are not the same in any two plants.

A near-sighted purchaser only sees the price per pound and the expense sheet is a month-to-month affair. The far-sighted purchaser pays little heed to the initial cost, but looks at the operating expense figured over a lapse of six months, or a year or years, and sees a relation between his expense for oil, grease or packing and the items for coal and repairs. Looking at the pound price only, the answer is simple—buy the cheapest and forget overtime work, repairs and increased loss of work due to increased friction, which loss shows decidedly in the amount of fuel used.

The far-sighted buyer chooses a packing that works with the least possible friction, thus reducing to a minimum the friction loss and unnecessary consumption of steam or coal. He will consult with his engineer in making his choice of packing and see to it that he knows the proper way to use that kind of packing and not abuse it. Packings need constant lubrication to prevent burning, and that should be insisted upon.

Having chosen the kind of packing, it remains to pick out the brand. This requires an analysis or tearing apart of the packing to determine the quality of the material as well as the workmanship; the best material and best workmanship will be the most economical in the end. A number of different brands may all hold back steam equally well, but some one will last the longest and that one, conditions being the same, will be the best to use.

Having purchased a particular brand of packing, it is well to start a record for each engine, at once, showing the hours run and the cost of packing for that machine. A good plan is to reserve some small duplex pump as a test machine, and test any new brand of packing on this machine before buying for stock. It is thus possible to eliminate poor packings at a very small expense.

In the instance of some rod packing, the pressure on the rod is produced by pressure from a gland, and is dependent upon the judgment of the operator. Often excessive pressure is applied and unnecessary friction is produced.

Moisture-expanding packings are generally composed of flax, either alone or in combination with duck. They are open to the same objection as gland-pressure packings, although, if properly used, the probability of excessive pressure is greatly reduced.

Heat-expanding packings are composed of rubber and duck. A good type contains rubber which acts as a cushion in the back of the packing. When cold the packing will leak; when hot it will have expanded and only a gentle pressure is produced on the rod. To get an excessive pressure on the rod, the packing must be compressed by the gland, which is positively wrong. It is superior to the preceding kinds of packing, but is really successful only on steam or when used in hot stuffing-boxes.

Automatic packings are ordinarily known as "diagonals." The pressure on the rod is caused by the pressure within the cylinder and varies with it; consequently, only the necessary pressure on the rod is produced and all the excessive pressure is eliminated. It is a very economical nonmetallic packing, from the standpoint of steam economy.

Soft metallic packing, which is a soft, babbitt-like metal, put up in various forms, will work well under good conditions of rod alignment, but, when once set, is hard and has no resiliency to adjust itself to faulty alignment, thus an elliptical hole is worn from which steam will escape. Hard-metal packing with wedge-shaped rings gives good service, but is more complicated than other hard-metal packings Hard-metal packing, with rectangular flanged rings, made in segments and held together by garter springs, gives excellent service.

Tests of packings, used on a small vertical engine, showed a friction load that was due almost entirely to the packing, as follows:

Gland-pressure packing, about 9 per cent. of the full load; heat-expanding packing, about 7 per cent., and automatic packing, between 8½ and 4 per cent. These results would probably not be the same on larger units, but they show clearly that the friction of packing of the gland-pressure type is over twice as much, and heat-expanding packing nearly twice as much as that of automatic or diagonal packing from the standpoint of steam economy.

The data on the friction of metallic packings are not complete enough to establish a reliable comparison, but it seems that the friction of a first-class metallic packing would be quite low and that it would rank in the same class as automatic packings in steam economy.

If unintelligent or cheap labor is employed it may not be advisable to use a high-grade packing, but ordinarily the best is the cheapest. Taking automatic packing and hard-metal packing with rectangular flanged rings as a basis interesting comparisons can be made. Assuming the cost of metallic packing for a 4-in. rod as $40, the automatic packing to fill this stuffing-box once would cost about $2. But this particular brand of soft packing has been known to last from one month to 3½ years; this latter service is rather exceptional. Taking three months as ordinary service, the soft packing would cost $8 a year, and at the end of five years the metallic packing would have paid for itself.

As metallic packing usually lasts much longer, this comparison is only suggestive. Each case must be figured out from its own records. If delays for repacking mean much loss or if continuous night-and-day service is necessary, the question is already settled in favor of the metallic packing, provided that it be of the best type.

It is as impossible to say just how much packing should cost per year as to say how much a man should spend per year for clothing; the service must be considered as well as the personality of the man using the goods. A systematic record for a year or two will give a basis for facts, and a preliminary study into the principles and construction will throw light on the factor of steam economy. Careful examination of various brands will insure a good start and save time, and after this the actual records will furnish grounds for deciding on what is best.

⁂

A Stumpf uniflow engine is producing 6600 hp. in a single cylinder at the works of Ehrhardt & Sehmer, at Scheibfmuhle, near Düsseldorf.

⁂

Interborough 30,000-Kw. Steam Turbines

An order has just been placed with the Westinghouse Machine Co., by the Interborough Rapid Transit Co., of New York City, for three 30,000-kw., horizontal, double-flow steam turbines, the generator ends of which will deliver three-phase, 25-cycle current. The high- and low-pressure elements will be in separate casings.

These units, with a total output of 90,000 kw., will replace three of the 5000-hp. angle-compound engines now being operated in the 59th St. station and the three low-pressure turbines operating on the exhaust steam from these engines. The combined 90,000-kw. turbine units will be accommodated within the space now occupied by the old engines.

No additions will be made to the boiler equipment, other than that the present boilers will be equipped with greater stoker capacity than hitherto to enable the boiler to produce the additional steam required by the larger generating units.

⁂

Universal Craftsmen's Meeting

The tenth annual convention of the Universal Craftsmen, Council of Engineers, was held at Boston, Mass., Aug. 5 to 8. The headquarters were at the Hotel Brunswick, and the several sessions of the delegates were held in the large banquet hall. There were about 180 delegates in attendance, and the business of the convention was conducted with harmony and dispatch.

The opening exercises took place at 11 o'clock on Tuesday morning, with George W. Knowlton in the chair. After the invocation by P. H. Early, grand chaplain, the address of welcome was made by Mayor John F. Fitzgerald, James U. Bunce, responding for the engineers. Interesting speeches were also made by William K. Campbell, president, Boston Engineers' Blue Room Club; Walter S. Cadwell, past worthy chief; Bradford L. Ames, president New England Association of Commercial Engineers, and Henry C. Senn, deputy grand chief.

At the close of the speeches the convention went into executive session, and after the various committees were appointed, an adjournment was taken until Wednesday morning at 9:30.

There was a varied program of entertainment, including auto trips through the shopping districts and park system, and other sight-seeing journeys.

On Tuesday evening the convention enjoyed a steamboat excursion to Nantasket Beach, the guests of the New England Association of Commercial Engineers.

On Wednesday afternoon, Everett C. Benton, grand master of Masons of Massachusetts, received the delegates and friends at the Masonic Temple.

On Wednesday evening the delegates and visitors were the guests of the Engineers' Blue Room Club, of Boston, on a trip to Revere Beach.

The principal feature of enjoyment was the reunion and entertainment on Thursday evening in the banquet hall of the hotel. A most enjoyable program of music, song and recital was given. Besides the local talent, Billy Murray, of Jenkins Bros., and Jack Armour, of "Power," gave numbers.

At the closing session of the delegates the following grand officers were elected: James U. Bunce, past worthy chief; Henry C. Senn, worthy chief; William H. Armstrong, assistant worthy chief; Charles F. Seigrist, secretary; Nathan J. Burdick, treasurer; O. N. Pomeroy, historian; H. E. Terry, warden; Frank M. Townsend, guard; P. H. Early, chaplain;

ATTENDANTS AT THE MEETING OF THE UNIVERSAL CRAFTSMEN, COUNCIL OF ENGINEERS, BOSTON, MASS.

Samuel J. Hunt, chairman board trustees; George C. Adwers and John MacMorran, trustees.

Cleveland, Ohio, was chosen as the place for the 1914 convention.

A fitting conclusion to the convention was the formation of a new council in Boston on Saturday night.

Canadian Engineers' Convention

The 24th annual convention of the Canadian Association of Stationary Engineers was held at Owen Sound, Canada, July 29, 30 and 31. The several sessions of the delegates were held in McLinden Hall, the lower floor of which was arranged and decorated for the use of the exhibitors' association of the C. A. S. E. for their mechanical display. There was a good attendance of delegates and visitors, and the reading of the reports of the committees showed the organization to be in a sound condition.

The opening exercises took place on Tuesday morning. Executive President J. A. Robertson introduced Mayor Elias Lemon, of Owen Sound, who welcomed the convention to the city. August Kastalla responded for the engineers and James E. Fiddes for the exhibitors. The delegates then went into executive session.

There was an enjoyable entertainment. On Tuesday evening the local lodge gave a banquet at which covers were laid for about 200 ladies and their escorts. After the dinner was served Toastmaster Fred Harrison introduced the following gentlemen, who made interesting and enjoyable addresses: Mayor Lemon, W. A. Crockett, W. S. Middlebro, M. P., C. S. Cameron, M. P., John Parker, James E. Keenan, W. E. Hoovey, "Dad" Wickens and James Rutherford. During the evening the following entertainers appeared: The Leslie trio, Harry Brown, W. S. Mann, John and Nellie McKeen, Horace Merry, Simms Brothers, J. E. Fiddes, E. F. Heatherington and John W. Armour.

On Wednesday afternoon an excursion by steamer was made to Kings Royal Park, where outdoor sports of all kinds were indulged in. There were prizes for the winners of each event. The baseball game between the Manufacturers and Engineers resulted in a victory for the latter by a score of 8 to 7. At the conclusion of the games dinner was served at the King's Royal Hotel, and after a short entertainment, dancing was enjoyed. There were also automobile trips about the city for the ladies.

At the closing session the following executive officers were elected: James A. Robertson, past president; Samuel E. Cosford, president; A. W. Heath, vice-president; August Kas-

DELEGATES AND GUESTS AT THE C. A. S. E. CONVENTION, OWEN SOUND, CANADA, JULY 29, 30 AND 31

talla, secretary; W. E. Archer, treasurer; J. Dyson, conductor; W. E. Hovey, doorkeeper.

The following officers were elected by the Exhibitors' Association: Ernest A. Wilkinson, president; A. C. Pulver, first vice-president; Boswell M. Walthall, second vice-president; B. G. Newton, treasurer; Gordon C. Keith, secretary; James N. Charles, assistant secretary; Earl F. Heatherington, chairman of executive committee; C. P. Archibald, chairman of entertainment committee; Carl N. Schrag, chairman of reception committee.

A silver-mounted casserole was presented to Joseph McLinden, and Ernest Hovey received an umbrella.

THE EXHIBITORS

The Lunkenheimer Co.	Peerless Rubber Manufacturing Co.
Canadian Morehead Manufacturing Co.	Canadian Fairbanks-Morse Co.
Standard Sanitary Manufacturing Co.	Dearborn Chemical Co.
Dart Union Co.	E. Leonard & Sons.
T. McAvity & Sons.	Garlock Packing Co.
Canadian Allis-Chalmers Co.	Ontario Lantern & Lamp Co.
Canadian H. W. Johns-Manville Co.	Quaker City Rubber Co.
Hugh C. MacLean Publishing Co.	Goldie & McCulloch Co.
Perolin Co.	James Morrison Brass Manufacturing Co.
Turner & Tupper.	"Canadian Manufacturer."
	"The Power House."
	"Power."

Ottawa, Ont., was chosen as the next place of meeting in July, 1914.

NEW PUBLICATIONS

LOGARITHMS FOR BEGINNERS. By C. N. Pickworth. Published in America by D. Van Nostrand Co., New York, 1913. Fourth edition. Cloth, 49 pages; 7¼x5 in. Four tables. Price, 50c.

The purpose of this book is to put before readers a treatise on logarithms in a style easily comprehended by the average student. As the title indicates the book is primarily for beginners.

The explanations of negative quantities and the arithmetical complement are excellent. The reader gets a brief but forcible account of the purpose and use of exponents, indices, and of what a reciprocal of a number is. To beginners these terms are perplexing and too many writers of textbooks fail to be elementary enough in their descriptions of them. Mr. Pickworth has avoided this offense.

A short table of four figures of common logarithms is given so the student may practice in the use of such tables. A table of hyperbolic logarithms is also included.

Altogether the book gives a more practical treatment of logarithms than is found in most mathematical textbooks.

EVOLUTION OF THE INTERNAL-COMBUSTION ENGINE. By Edward Butler. Published by Charles Griffin & Co., Ltd., London, and by J. B. Lippincott Co., Philadelphia. Cloth: 237 pages, 6x9 in., illustrated. Price, $3, net.

This is not a historical sketch of the internal-combustion engine, as might be inferred from the title, but instead, treats of the more important problems of design as met in the modern oil and gas engine. Chapters are devoted to the following divisions of the subject: Four-stroke-cycle engines, scavenging, two-stroke-cycle engines, compound explosion engines, thermodynamic considerations, internal-combustion turbines, admission and exhaust valves, methods of governing, carburetion, cooling and lubrication.

Large gas and oil engines are discussed to some length both from an economic and a constructive point of view. Special types of small motors such as the sliding sleeve and revolving-cylinder types are also taken up.

Nearly two hundred illustrations are included, and these are well chosen, but in point of criticism, it may be added that the drawings are very poorly executed.

The book is not an elementary treatment of the subject, but is intended for those already familiar with the principles of gas and oil engines. As such it serves a useful purpose in setting forth many of the problems of design and the ways in which they have been met by previous designers.

SAFETY METHODS FOR PREVENTING OCCUPATIONAL AND OTHER ACCIDENTS AND DISEASE. By William H. Tolman, Ph. D., Director of the American Museum of Safety, and Leonard B. Kendall. Published by Harper & Bros., New York, 1913. Size 5½x8½; 422 pages; cloth. Price $3.

The question of safety is taken up from both a social and an economic standpoint and it is estimated that the annual loss in this country alone through industrial accidents amounts to approximately $250,000,000, half of which is preventable in the opinion of those who have given the subject careful study. It is also shown that the average compensation is $400 of which the plaintiff's lawyer usually receives half.

A brief review is given of how the problem is handled in Germany. Every German employer belongs to the trade association of his business and he pays into this association a premium to insure his workmen's safety, the amount being determined by the size of his payroll and the risk of his business. In the event of an accident to one of his employees, an investigation is made by his associates and if blame attaches to the employer he is heavily fined.

The book takes up in detail various classes of industries including steelworks, mining, electrical accidents, cutting and grinding tools, illumination, fire protection and prevention and general aids to safety. Under the heading "Industrial Hygiene" is shown how committees on sanitation are at work, the effects of industrial poison, and the ways in which they may be prevented or reduced to a minimum.

The work of the Museum of Safety along the lines of industrial education is gone into fully. A number of carefully selected illustrations add to the attractiveness of the book and forcibly emphasize the arguments laid down in the text.

Methods of Analyzing Coal and Coke

Technical paper 8 on "Methods of Analyzing Coal and Coke," by Frederic M. Stanton and Arno C. Fieldner has just been issued by the Bureau of Mines. In January, 1912, the first edition of this paper was published, but due to a number of inquiries for additional information in regard to details of sampling or analytical work that were not discussed at length in that edition and because the bureau has modified and improved various details of its laboratory practice the present paper was issued. Some radical changes were made in the text matter, and several new illustrations added. The paper first takes up the preliminary treatment of samples and continues with the method of calculating and recording analyses, method of analysis, determination of the calorific value of coal, determination of the true specific gravity of coal and coke substance and determination of the apparent specific gravity. The subjects are fully discussed and illustrated so that the paper should meet all needs.

Smokeless Combustion of Coal in Boiler Furnaces

The Bureau of Mines has just issued Bulletin 40, which is a reprint of U. S. Geological Survey Bulletin 373, revised by Henry Kreisinger. The authors of the original bulletin were D. T. Randall and H. W. Weeks. The Bureau of Mines has made extended tests to determine the conditions necessary for the smokeless combustions of bituminous coal in boiler furnaces. In the investigations of industrial establishments a study was made of the conditions in 13 of the larger cities in Illinois, Indiana, Kentucky, Maryland, Michigan, Missouri, New York, Ohio and Pennsylvania, between 400 and 500 plants being inspected. Sufficient information was collected to make the data from 284 plants of value for this report. In nearly every city visited coal was supplied from points both in and out of the state, so that although nine states were visited the facts ascertained apply to coal from a greater number. The main purpose of the inspection was to obtain a better knowledge of the influence of furnace design, and of the conditions under which combustion takes place, on the production of smoke. The summary of conclusions as given in the Bulletin will indicate what was learned by the tests.

A furnace, well designed and operated, will burn many coals without smoke up to a certain number of pounds per hour, the rate varying with different coals, depending on their chemical composition. If more than this amount is burned, the efficiency will decrease and smoke will be made, owing to the lack of furnace capacity to supply air and mix gases.

Extremely high volatile matter in the coal usually gives low efficiency. The highest efficiency was obtained when the furnace was run at low capacity. When the furnace was forced the efficiency decreased.

With a hand-fired furnace the best results were obtained when firing was done most frequently, with the smallest charge.

Small sizes of coal burned with less smoke than large sizes, but developed lower capacities.

Peat, lignite and sub-bituminous coal burned readily in the type of tile-roofed furnace used and developed the rated capacity with practically no smoke.

Coals that smoked badly gave efficiencies 3 to 5 per cent. lower than the coals burning with little smoke.

Briquettes were found to be an excellent form for using slack coal in a hand-fired plant. They can be burned at a fairly rapid rate of combustion with good efficiency and with

practically no smoke. High-volatile coals when briquetted are perhaps as valuable as low-volatile coals when not briquetted.

A comparison of tests on the same coal washed and unwashed showed that under the same conditions the washed coal burned much more rapidly than the raw coal, thus developing high rated capacities. In the average hand-fired furnace washed coal burns with lower efficiency and makes more smoke than raw coal. However, washed coal offers a means of running at high capacity, with good efficiency, in a well designed furnace.

Forced draft did not burn coal any more efficiently than natural draft. It supplied enough air for high rates of combustion, but as the capacity of the boiler increased the efficiency decreased and the percentage of black smoke increased.

Most coals that do not clinker excessively can be burned with 1 to 5 per cent. greater efficiency and with a smaller percentage of black smoke on a rocking grate than on a flat grate.

Air admitted freely at firing and for a short period thereafter increases efficiency and reduces smoke.

As the CO in the flue gas increases, the black smoke increases; the percentage of CO in the flue gas is therefore, in general, a good guide to efficient operation. However, owing to the difficulty of determining this factor, combustion cannot be regulated by it.

Very complete data are tabulated in the bulletin, and a number of types of furnace and methods of baffling are illustrated. A chapter on "Central Heating Plants" is also included.

SOCIETY NOTES

The annual outing and clambake of No. 7, N. A. S. E., of New York, at Douglaston, L. I., on Sunday Aug. 3, was the largest in the history of the association. About 300 ladies and gentlemen enjoyed the dinner.

On Sunday, Aug. 10, Stevenson Association No. 44, N. A. S. E., of New York, held its outing at Grant City, S. I. There was the usual large attendance. There were outdoor sports of all kinds, and dancing concluded the day's fun.

The 18th anniversary reunion and field day of Pawtucket Association No. 2 of the National Association of Stationary Engineers, was held at Palace Gardens on Narragansett Bay, R. I., on Sunday, July 27. Fully 400 were in attendance and a most enjoyable day was spent. After the clambake the company adjourned to the pavilion, where the "Bunch" gave an entertainment. The feature of the day was the baseball game between the Pawtucket boys and the "Bunch," the latter winning by a small margin after a most exciting game.

PERSONALS

C. C. Witt, for two years engineer with the Kansas Public Utilities Commission, has resigned to accept service under the Interstate Commerce Commission. T. J. Strickler succeeded Mr. Witt as engineer with the Kansas Commission.

J. F. Mallory, formerly with the Taylor Stoker Co., is now connected with the B. F. Sturtevant Co. at the New York office, 50 Church St., makers and selling agents of the Riley self-dumping underfeed stoker for the Sanford Riley Stoker Co., Worcester, Mass.

OBITUARY

Eugene O. Reuleaux died suddenly of heart failure at Indianapolis, Ind., Aug. 6, 1913.

He studied mechanical engineering in Berlin under his father, Prof. F. Reuleaux, author of "The Constructor," until about the age of 16, when he came to the United States, settling in St. Paul.

He has held many important positions with the Westinghouse Machine Co. and Dodge Manufacturing Co., and a short time before his death was general superintendent of the American Rotary Valve Co., of Anderson, Ind. He left a wife and two sons.

BUSINESS ITEMS

The American Engineering Co., Philadelphia, Penn., has recently booked orders for 20 installations of Taylor stokers, seven of which represent repeat orders.

The Avery Scale Co., North Milwaukee, Wis., has engaged C. A. Weaver for its representative in the Northwest, with headquarters at Room A-1 Chamber of Commerce, Minneapolis, Minn.

The B. F. Sturtevant Co., Hyde Park, Mass., has arranged for a plant in Galt, Ont., to handle the company's business in Canada and also to export to England, Australia and other foreign countries.

The Springfield Boiler & Manufacturing Co., Springfield, Ill., has purchased the rights, patents, and good will of the Flanner water-tube boiler, which was previously built by the Toledo Flanner Boiler Co., of Toledo, Ohio.

The Terry Steam Turbine Co., Hartford, Conn., have appointed Hoshall, Simmons & Co., 502 Randolph Building, Memphis, Tenn., as their agents for that city and the territory of Tennessee, Arkansas, and the northern part of Mississippi.

The Yarnall-Waring Co., Chestnut Hill, Philadelphia, Penn., is sending out free a very attractive cardboard model of the Simplex seatless blow-off valve. This model gives an excellent idea not only of the construction, but also of the operation. The company will be glad to send one of these models to any "Power" reader on request.

Contrary to prevailing opinions on conditions throughout the country, some manufacturers are almost overwhelmed with business. The Terry Steam Turbine Co., Hartford, Conn., has just started operating on a 23-hour per day basis, the one hour of idleness being from six to seven in the morning. It is found necessary to do this in order to clear the shop from the present crowded condition, due to congestion of orders during the past few months. June is reported to have been the biggest month ever experienced by the company.

Owing to the rapid growth of the Elliott Co., Pittsburgh, their present works have been for some time entirely inadequate. They have recently purchased the works of the Clifford-Capell Fan Co., at Jeannette, Pennsylvania, and are now engaged in remodeling the buildings, and making them suitable for their regular line of business, and in addition are preparing to construct a new foundry, 300x150 ft. The new works are located on 33 acres of ground adjacent to Jeanette, and the buildings already in place will represent an increase in floor space of about 2½ acres. They expect to complete their improvements and additions to their new works by October, after which at least their heavier tools will be moved to that plant.

The Bruce-Macbeth Engine Co., Cleveland, Ohio, has recently booked the following orders for their vertical multi-cylinder gas engines: Two 100-hp. four-cylinder engines for the Snow Steam Pump Works for installation in Louisiana; one 60-hp. twin cylinder engine for the American Glove Co., Dunkirk, N. Y.; one 150-hp. engine for the Interstate Cotton Oil Refining Co., Sherman, Tex. Among recent shipments were one 150-hp. engine for the Fry Glass Co., Rochester, Penn.; one 150-hp. for John Eichlay, Jr., Pittsburgh, Penn., and one 350-hp. for the Sydenham Glass Co., of Canada.

The growth of the business of the Coppus Engineering & Equipment Co., Worcester, Mass., has compelled the removal to new and larger shops at 166 Union St.

Manning, Maxwell & Moore, Inc., of New York City, together with their subsidiary companies, will move their general offices on or about Oct. 1, from 85-89 Liberty St., to the new Lewisohn Building, 113-119 West 40th St. (near Broadway, and running through to 114-118 West 41st St.) This change is being made to meet for a more convenient and central location, as well as larger space to handle material increases in their various lines, which cover electric traveling cranes, machine tools, engineering specialties, railway, machinists', engineers', factory and contractors' supplies. A large portion of this product is manufactured by their constituent companies: The Shaw Electric Crane Co., the Ashcroft Manufacturing Co., the Consolidated Safety Valve Co., the Hayden & Derby Manufacturing Co. and the Hancock Inspirator Co. They will occupy the 20th and 21st floors of the above building, which will give them 28,000 sq.ft. of space. This space will be exclusively for offices, and is almost double that at present occupied for offices on Liberty St.

TRADE CATALOGS

S. F. Bowser & Co., Inc., Fort Wayne, Ind. Pamphlet. A collapsible oil filter. Illustrated, 24 pages, 6x9 inches.

The United States Graphite Co., Saginaw, Mich. Booklet. "What Users Say About It." Mexican boiler graphite. Illustrated, 64 pages, 5x8 inches.

The Vilter Mfg. Co., Milwaukee, Wis. Bulletin No. 22. "Plate Ice and Raw Water Can Ice as Affected by the Mineral Salts in Water." 20 pages, 6x9 inches.

National Tube Co., Frick Building, Pittsburgh, Penn. Booklet. The Whole "Kewanee" Family. Unions, union ells and tees, boiler couplings, etc. Illustrated, 48 pages, 5½x8 inches.

Hughson Steam Specialty Co., First National Bank Building, Chicago, Ill. Catalog D. Eclipse steam specialties. Valves, pump governors, water columns, steam traps, etc. Illustrated, 40 pages, 5½x8½ inches.

Harrison Safety Boiler Works, 17th St. & Allegheny Ave., Philadelphia, Penn. Catalog Section A. Live steam separators. Illustrated, 20 pages, 6x9 inches. Catalog Section B. Live-steam separators and receivers. Illustrated, 32 pages.